

# Final Report

Characteristics of the Navy Laboratory/Warfare Center Technical Workforce

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# Characteristics of the Navy Laboratory/Warfare Center Technical Workforce

Lisa M. Frehill<sup>1</sup> and Michael Jobe<sup>2</sup>

29 September 2013

## 1. Introduction

This report provides a demographic snapshot of the technical workforce employed at the Naval Research Laboratory (NRL) and Navy Warfare Centers as compared to the national technical workforce for 2012. This study is a follow-up to the 2009 study titled “Report on Navy Laboratory and Warfare Center Demographics” by David M. Drumheller and James C. Meng, which is an addendum to this document. As with that previous report, all workers within specified occupational series were grouped as the “Navy technical workforce” with no distinction made between the Navy’s science and technology (S&T) workforce, which is supported by BA1 (6.1) through BA3 (6.3) funding and those who are supported from other budget activities (including, for example, the acquisition workforce).

The Navy technical workforce was sub-divided into six broad occupational groups: Life Science (Life), Physical Science (Physical), Engineering (Engineering), Mathematics (Math), Computer Science and Information Technology (CS/IT) and Economics and Psychology (Econ & Psych). These six fields differ, slightly, from those reported in 2009: Appendix A provides a

### **Definition: Navy Labs Technical Workforce**

The *Navy Labs total workforce* includes all civilian employees at one of five locations associated with 72 Unit Identification Codes. The technical workforce is then defined by occupational series: individuals who are in one of 44 occupational series specified as S&T by the Office of Naval Research are considered the “*Navy Labs Technical Workforce*.” Full details are in Appendix B.

replication of the 2009 analysis, which included only five broad fields<sup>3</sup>. As noted in the 2009 report, the Navy technical workforce remains comprised mostly of engineers, is predominantly white and male, with uneven age profiles, with a large overrepresentation of late-career workers and a dearth of mid-career workers. There was also considerable spread in the median ages among the broad occupational groups, with economists and psychologists

being the youngest (with a median age of 39) and the physical scientists being the oldest (49 median years old).

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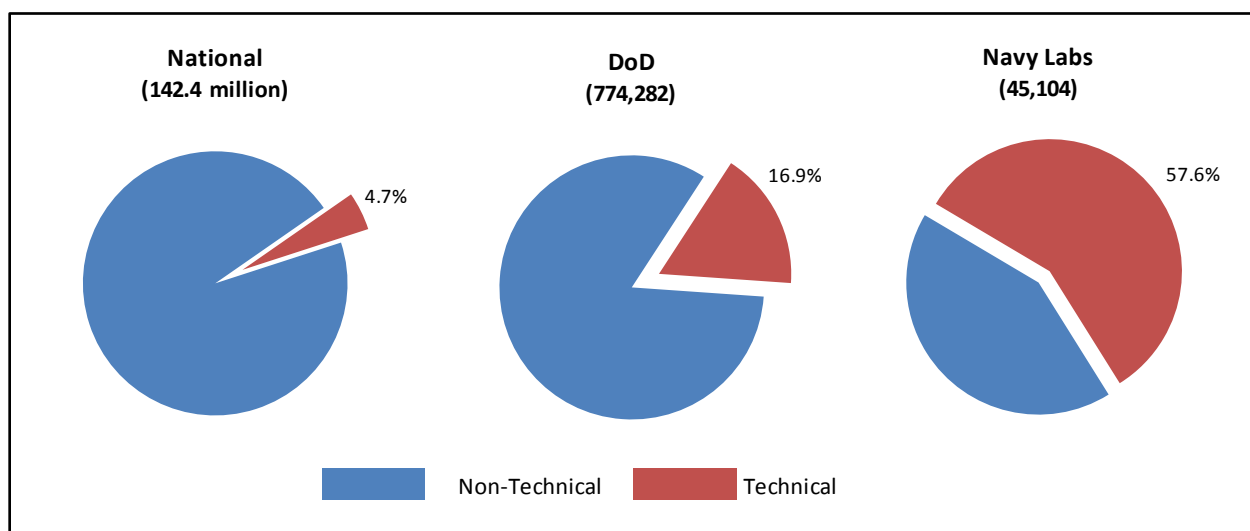
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<sup>3</sup> The 2009 analysis combined mathematics and computer science, a common practice. In the past few years, however, as the information technology workforce has grown at a pace that far surpasses that of mathematics, strategic workforce planning efforts are enhanced by separating these fields. Comparability to national-level statistics is also improved via this process. Also, in the 2009 analysis economics and psychology were referred to as “Social sciences,” but in most other national reports, a number of other fields are typically included in this category, so we have opted for a more precise label that specifies the fields.

Data used in this analysis, which is described in Appendix B, was provided by the Defense Manpower Data Center (DMDC) and the Bureau of Labor Statistics (BLS). Appendix B describes how the technical workforces were defined with respect to Federal Civil Service General Schedule (GS) Occupational Series and BLS-defined occupations.

## 2. Overview: The Technical Workforce: National, DoD and Navy Laboratory/Warfare Centers (Navy Labs)

Figures 1 and 2 show the relative size of the technical workforce in the national context, the DoD and within the Navy Laboratories/Warfare Centers (hereafter simply “Navy Labs”). Figure 1 shows that just 4.7 percent of the 142 million members of the civilian employed national workforce are in jobs included in the ONR-specified set of technical occupations. These occupations are a much larger proportion of the DoD and Navy Labs workforces, with about three times the national level (16.9 percent) of DoD’s 774,282 workers and over one half (57.6 percent) of the Navy Labs 45,104 civilian employees in these technical positions.

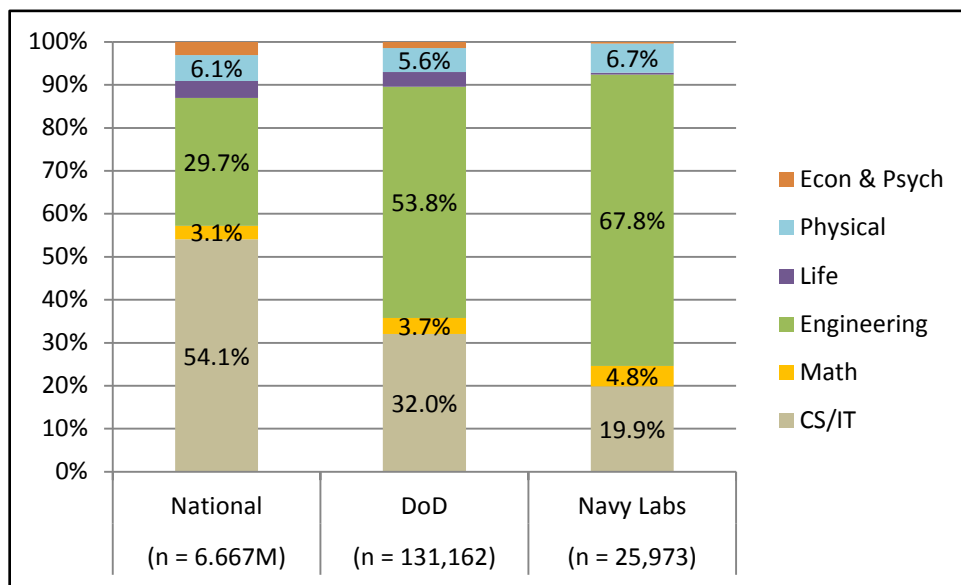


**Figure 1. Relative Size of Technical Workforces, 2012<sup>4</sup>**

Figure 2 shows the broad disciplinary fields for the three technical workforces: national, DoD and in the Navy Labs. More than half of the national technical workforce is in the rapidly growing computer science/information technology (CS/IT) occupations, but just 32 percent of DoD and 19.9% of Navy Labs technical workers are in these positions. Engineering is, by far, the largest group of technical workers in the DoD (53.8 percent) and of Navy Labs (67.8 percent)

<sup>4</sup> Table notes: Technical workforce is as defined by the Office of Naval Research, shown in Appendix B, as applied to U.S., DoD, and Navy Laboratories / Warfare Centers workforce data. The national workforce shown (142.4 million) include those who are currently employed.

as compared to 29.7 percent of the national technical workforce. Together, two of the six broad occupational groups, CS/IT and engineering, comprise 87.7 percent of the Navy Labs technical workforce. The size of the physical sciences workforce relative to each of the three technical workforces in Figure 2 is relatively similar, ranging from 5.6 to 6.7 percent, as is the relative size of the mathematics workforce, which ranges from 3.1 percent of the national technical workforce to 4.8 percent of the Navy Labs technical workforce.



**Figure 2. Broad Occupational Groups of Technical Workforces, 2012**

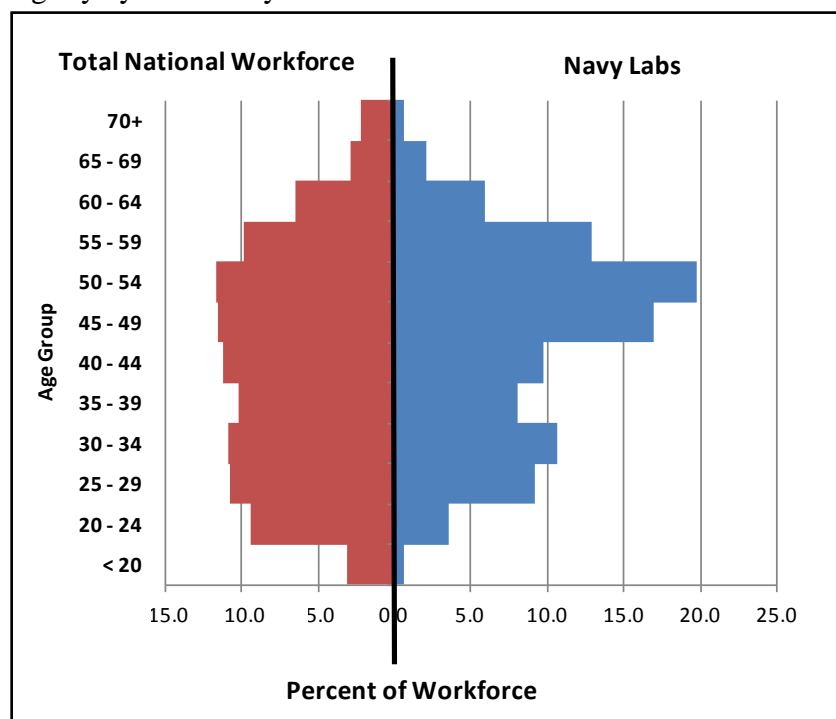
### 3. Analysis of Workforce Data

#### 3.1 Overall Age Distribution

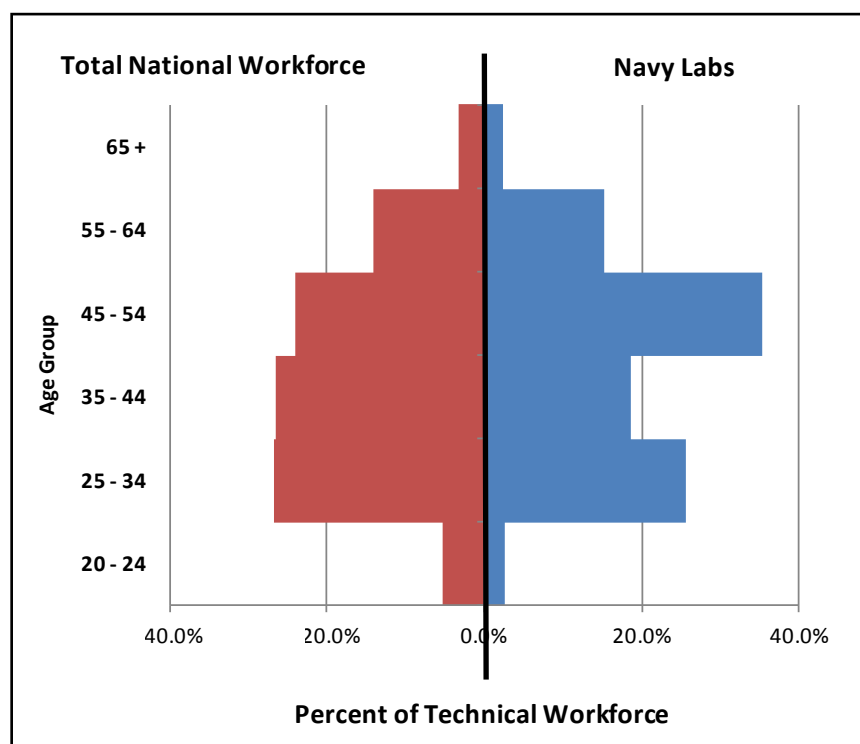
Figure 3 shows age distributions for the total national and the Navy Labs workforces (all civilians in all jobs—see the more detailed chart in Appendix C). The overall national workforce follows a relatively uniform distribution across the six age groups between 25-29 and 50-54 (inclusive), with approximately 10 percent of workers in each group. The Navy Labs workforce differs: it is a bit “top heavy” with 17 percent of workers aged 45-49 and another 19.8 percent in the 50-54 year old age group. As shown in Appendix A, the age peak has shifted in comparison to what was shown in 2009, when 21.6 percent of the Navy labs total workforce was aged 45-49 years and with low levels of hiring of younger workers. In all, 58 percent of the Navy Labs employees are 45 or older versus just 44 percent of the total national workforce. Over the next decade, as the large cohort of late career employees retire, the Navy Labs will need to train the 35-44 year old cohort to assume responsibility from the retiring group.

Figure 4 shows the age profile of the Navy technical workforce as compared to the national technical workforce; due to national data limitations, age is shown in 10-year rather than

the 5-year increments in Figure 3. This graph shows an even starker difference between the Navy Labs and national technical workforces, with the bimodal distribution for Navy but a slightly “youth-heavy” distribution for the national technical workforce.



**Figure 3. Age Distribution: Navy Labs vs. Total National Workforce, 2012**



**Figure 4. Age Distribution of Technical Workforces, 2012**



### **3.2 Age Distribution within Broad Occupational Group**

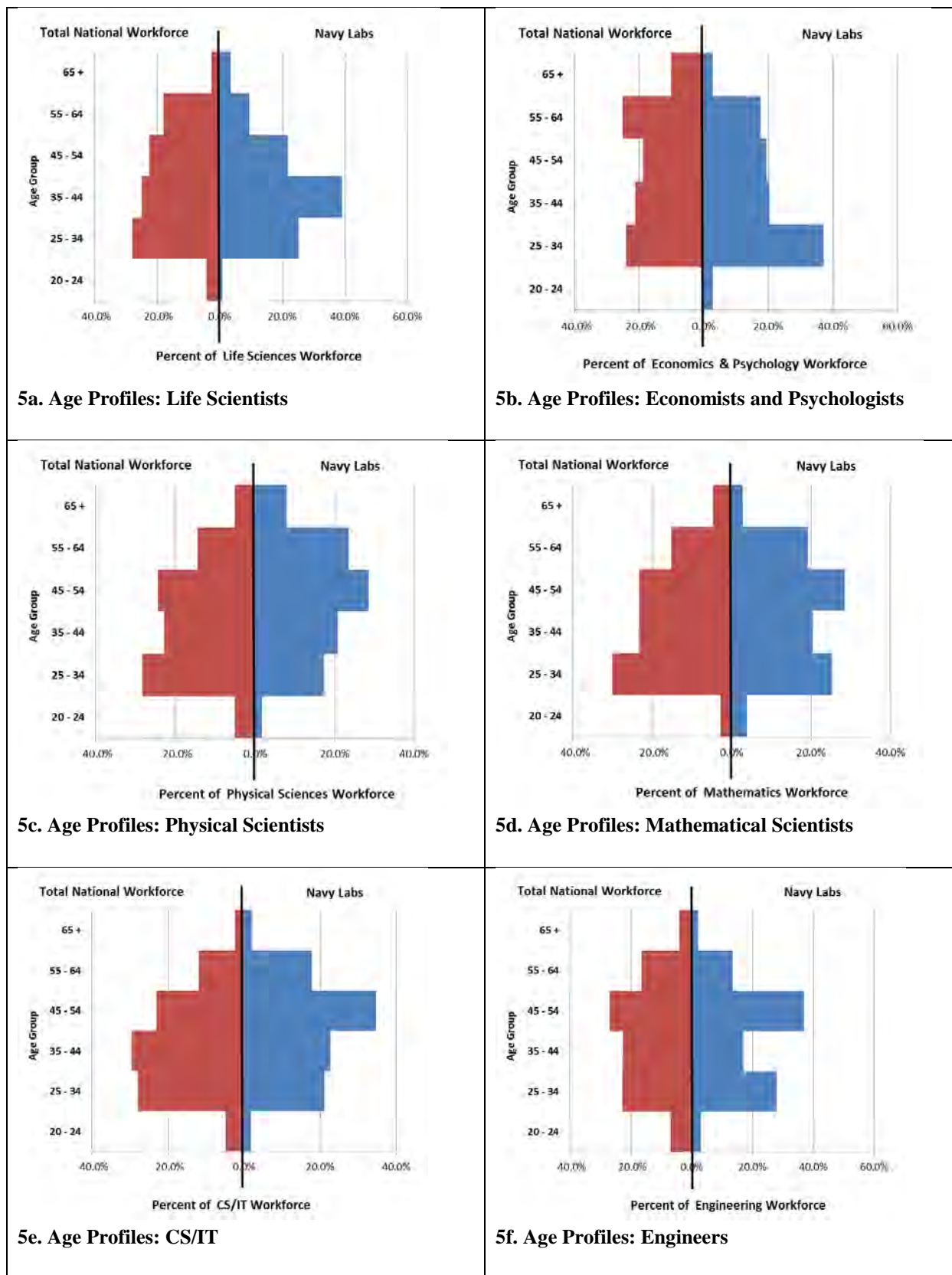
Figure 5 shows age distributions of the Navy technical workforce for each broad occupational group compared to the relevant groups in the national technical workforce. The age distribution of the Navy life sciences workforce is similar to the national one with a slight skewing of the distribution towards the younger age groups. The principal difference is that 39 percent of Navy's life scientists are aged 35-44 (versus 24.8 percent nationally) and while 17.9 percent of the national life science workforce is aged 55-64, just under 10 percent of the Navy life sciences workforce is in this senior career category as shown in Figure 5a. Likewise, Figure 5b shows that the Navy economics and psychology workforce has a markedly younger age profile than does the national one in these fields.

The Navy physical sciences age profile shown in Figure 5c is in stark contrast to that of the life sciences, economics and psychology and the national physical sciences workforces, with a pronounced skew towards the older age groups. Indeed, 31.5 percent of the Navy but just 19.5 percent of the national physical sciences workforce is 55 or older.

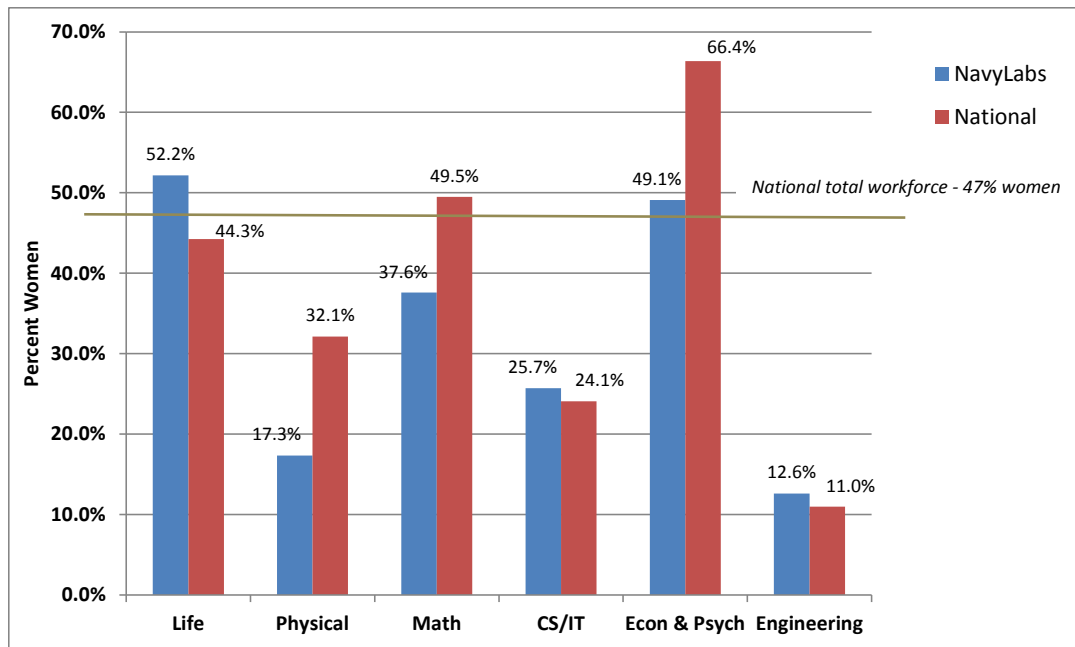
The age profiles of the Navy Labs mathematics (Figure 5d) and CS/IT (Figure 5e) workforces are quite different from those for the national workforces in these broad occupational groups. The national workforces in these occupational groups are younger, while the Navy Labs workforces in these fields are older. In addition, both the Navy Labs engineering (Figure 5f) and mathematics workforces have a distinctive bimodal shape, with a discernible workforce gap for workers aged 35-44, who are generally considered to be approaching mid-career. In both cases, though, the smaller relative number of workers aged 25-34 in these same occupational groups may signal an impending workforce concern about whether there will be sufficient talent in the Navy Labs mathematics and engineering workforces to satisfy future workforce needs. This issue is explored in more detail in Section 4.

### **3.3 Gender**

Figure 6 shows the percentage of women in each broad occupational group for the Navy and national technical workforces. Overall, women account for nearly half of the total national workforce (47 percent) but women's representation across the technical occupational groups varies. The Navy Labs are on par with national-level data on women's representation in CS/IT and engineering, even though these fields have relatively low rates of women's participation (i.e., women's underrepresentation in these fields is a national issue). Women account for just 11 percent of engineers in the total national workforce and are 12.6 percent of the Navy Labs engineering workforce. About one-in-four Navy Labs and total national workers are women in the CS/IT occupations.



**Figure 5. Age Profiles of National and Navy Labs Technical Workforces, 2012**



**Figure 6. Women as a Percent of Workers in Each Broad Occupational Group, 2012**

In physical sciences, economics and psychology and mathematics, women's representation in the Navy Labs lags women's representation in these same occupational groups in the national workforce by a sizable gap. These findings suggest, therefore, that the Navy may not be effectively recruiting from the pool of available talent in these scientific fields. In the physical sciences, the gap may be due to the preponderance of workers from older age groups in the Navy Labs. In mathematics and economics and psychology, however, it is unclear why this gap exists. Finally, the Navy technical workforce in the life sciences is slightly more than half women (52.2 percent), exceeding the national total workforce representation of women in these fields, but on par with recent graduation cohorts from U.S. colleges and universities.

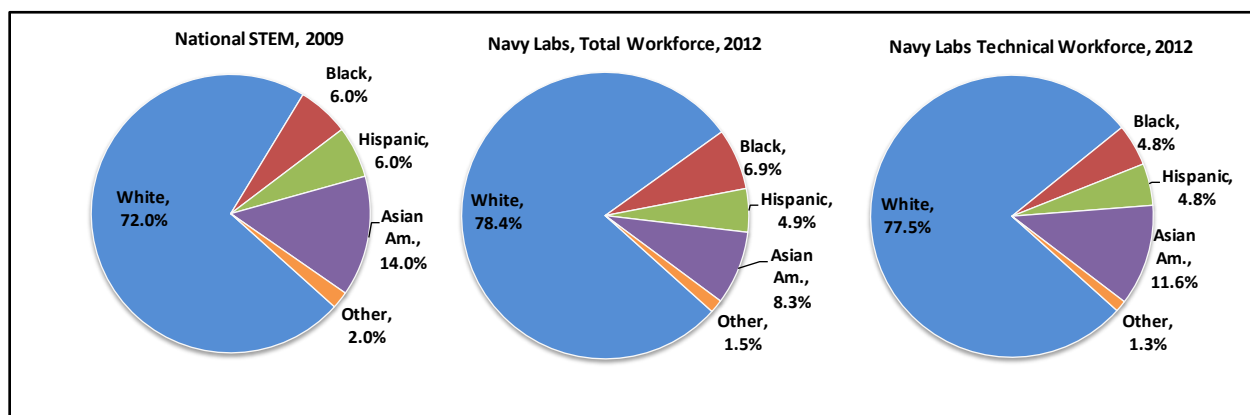
### 3.4 Race/Ethnicity

Comparable national technical workforce data on race/ethnicity were not available for 2012. Therefore, Figure 7 shows the Navy Labs total and technical workforce by race/ethnicity for 2012 compared to the most recent (2009 data published in 2011) national-level data on the STEM workforce<sup>5</sup> from a publication of the Economics and Statistics Administration of the U.S. Department of Commerce.

Figure 7 shows that the Navy Lab workforce, both overall and the technical workforce specifically, has a slightly higher representation of white workers than does the national STEM workforce. Both Blacks and Hispanics are underrepresented in the Navy Labs technical

<sup>5</sup> The term "STEM" refers to science, technology, engineering and mathematics. ESA reports on STEM occupations include a larger number of occupational groupings than does the ONR technical workforce specification.

workforce when compared to either the Navy Labs’ overall workforce or the national STEM workforce. Asian Americans are underrepresented in the Navy Lab’s technical workforce (11.6 percent) when compared to the national STEM workforce (14 percent), but over represented compared to the total Navy Labs’ workforce (8.3 percent).



**Figure 7. Race/Ethnicity of Navy Labs Workforce Compared to National Technical Workforce<sup>6</sup>**

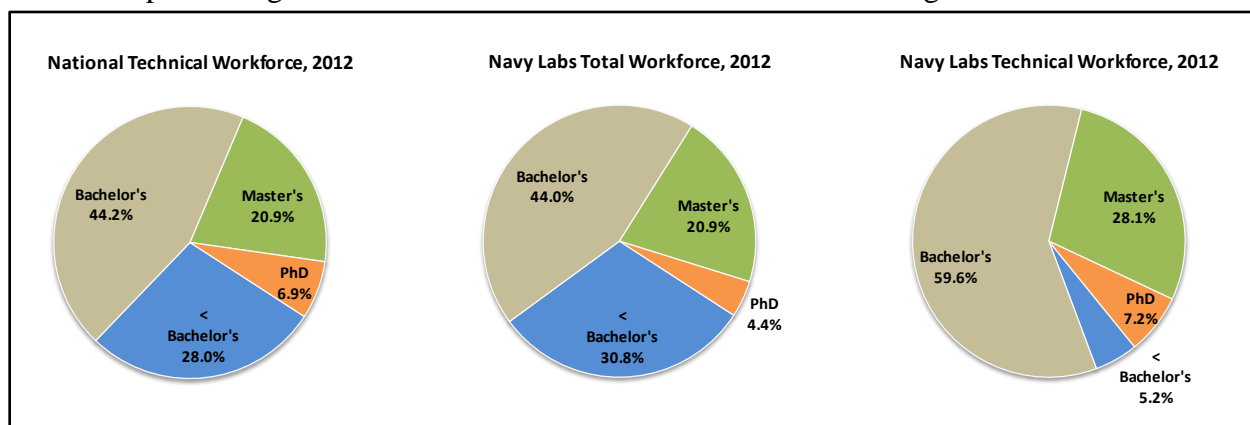
### 3.5 Education

The most recent national data disaggregated by occupation were for 2009 from the national employment matrix used by Bureau of Labor Statistics for labor force projections. New data are likely to be available in 2014 with the publication of the biennial *Occupational Outlook Handbook*. As shown in Figure 8, the Navy Labs technical workforce is somewhat more highly-educated than the total Navy Labs workforce and the national technical workforce. Members of the Navy Labs technical workforce (28.1 percent) are more likely than those in the national technical workforce (20.9 percent) to hold a master’s degree and are less likely than those in either the full Navy Labs workforce or the national technical workforce to possess less than a bachelor’s degree. Finally, the Navy Labs technical workforce has a higher proportion of PhDs (7.2 percent) than the national technical workforce (4.4 percent).

These differences are not surprising, given the differences in the relative sizes of the broad occupational groups that comprise each workforce (see Figure 2); more than half of the national technical workforce but just under 20 percent of the Navy Labs technical workforce was in CS/IT. As will be shown in more detail in Section 4 of this report, the educational background of the CS/IT workforce is very heterogeneous, with 35.9 percent in the 2009 national technical

<sup>6</sup> The source of national data in Figure 5 is: U.S. Department of Commerce, Economics and Statistics Administration. (2011). “Education Supports Racial and Ethnic Equality in STEM” *ESA Issue Brief #05-11*, September 2011. ESA includes in its “STEM” category of occupations most, but not all, of the “Computer and mathematical” occupations, all of the engineering occupations, all physical and life science occupations that are included in the ONR specification of “technical workforce.” However, the ESA includes a number of occupations that ONR’s specification does not include, such as technicians and STEM managers and ONR includes economists and psychologists, which are not included in the ESA STEM category.

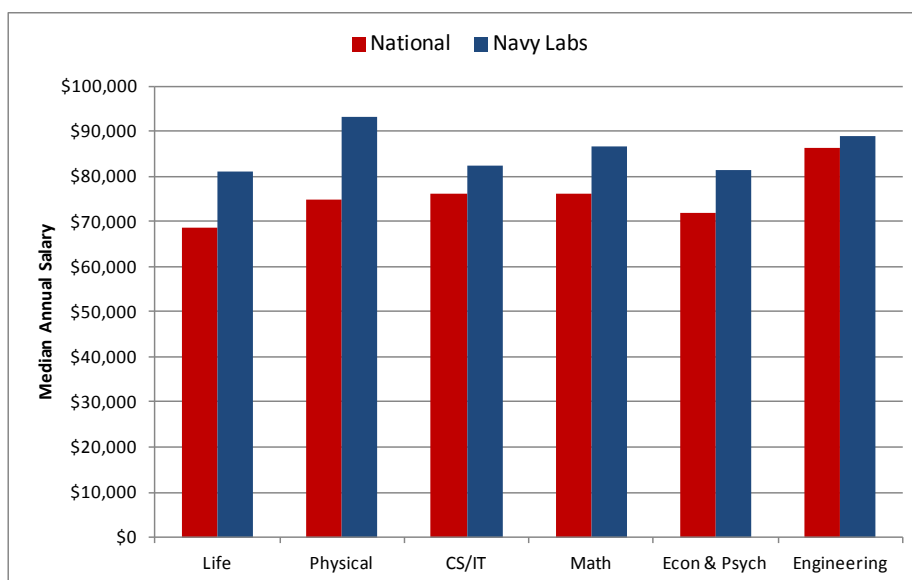
workforce possessing an educational credential below the bachelor's degree.



**Figure 8. Educational Backgrounds**

### 3.6 Salary

Figure 9 shows the median salary for each broad occupational group in the national technical workforce compared to the Navy Labs technical workforce. The national salary data were taken from the BLS Occupational Employment Survey, which are data provided by employers who report on part-time and full-time workers paid a wage or salary. The Navy Labs technical workforce salary data analysis was restricted to the 24,968 individuals who were on full-time work schedules, had salaries reported per annum, and had no special pay codes<sup>7</sup>.



**Figure 9. Annual Salaries: Navy Labs Compared to National Technical Workforce, 2012**

<sup>7</sup> These restrictions alone or in combination applied to 1,005 members of the Navy Labs technical workforce. Special pay codes refer to rates that deviate from the GS. “Retained pay, same position” of “special and superior qualified rate” are two examples of special codes.

In every broad occupational group – taking no other factors into consideration – the median earnings of the Navy Labs technical workforce exceeded those of the national technical workforce. Overall, Figure 9 suggests Navy Labs technical workforce employees have higher median incomes than those in similar occupational groups in the national technical workforce.<sup>8</sup>

Figure 10 shows median salaries for the Navy Labs technical workforce separately by degree level and broad occupational group. Among those with bachelor's and master's degrees, the relatively younger life sciences and economics and psychology workforces had lower median earnings than those at similar degree levels in other technical occupational groups. Doctoral-degreed life scientists' median earnings were lower than those of other doctorate holders in the Navy Labs technical workforce. Indeed, life scientists with PhDs earned median salaries lower than those of master's degree-level Navy Labs employees in the other four groups.

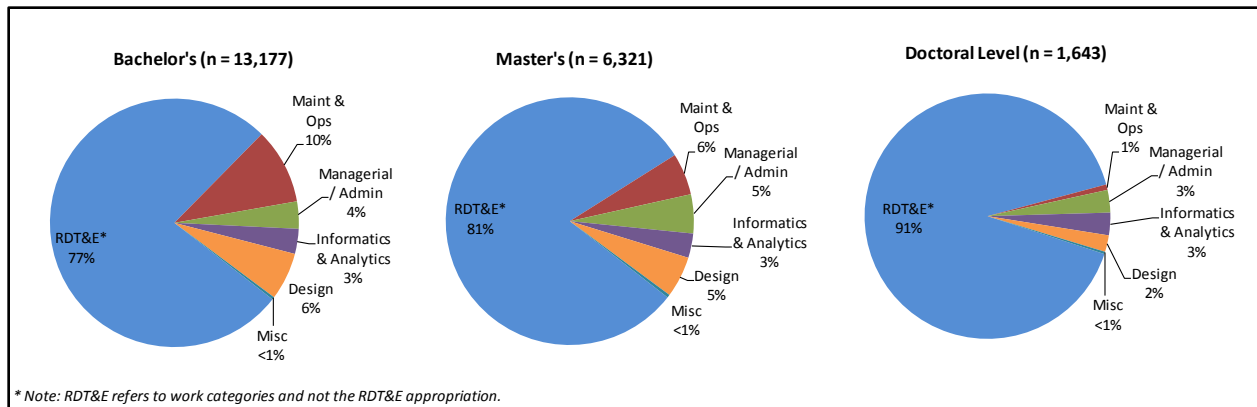


**Figure 10. Annual Salaries by Education and Broad Occupational Group, Navy Labs 2012**

### 3.7 Functions: What Kind of Work Does the Navy Technical Workforce Do?

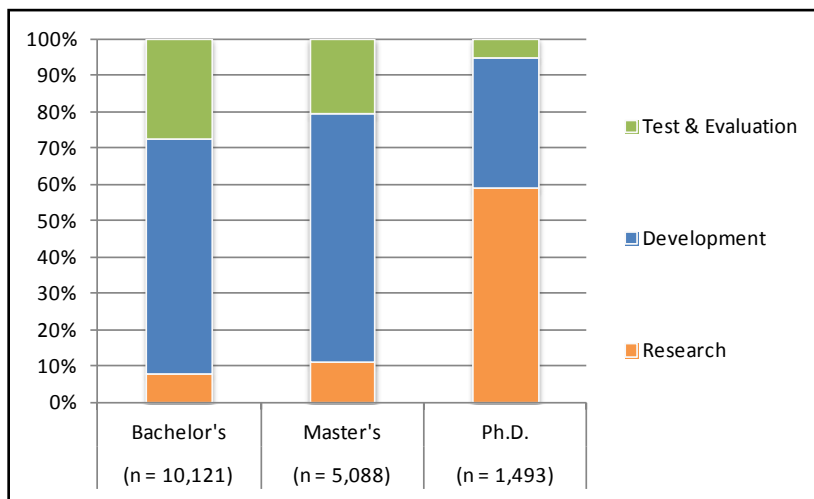
Figure 11 summarizes the primary functions reported for the Navy Labs technical workforce by degree level. Appendix B shows the methodological details associated with how the 18 original categories for job functions were aggregated into those shown in Figure 11. A majority of the technical workforce is in one of the three job functions that are shown as “Research, development, test and evaluation (RDT&E),” in Figure 11 which varies from 77 percent for those with bachelor's degrees to 91 percent for PhDs.

<sup>8</sup> Some caution is in order for interpreting these figures. First, the national data include both part-time and full-time workers' earnings, therefore, the lower earnings of part-time workers would lead to lower estimated national medians versus those for the Navy Labs, which were restricted to full-time workers. Also, the medians include all age groups, which obscures likely pay differences associated with career stage. The previously noted demographic differences (i.e., overrepresentation of late-career workers) may bias median salaries of the Navy technical workforce toward higher values. Similarly, national-level data simultaneously disaggregated by education level and detailed occupation were not available. Higher levels of education are strongly correlated with annual salary.



**Figure 11. Work Functions of the Navy Labs Technical Workforce<sup>9</sup>**

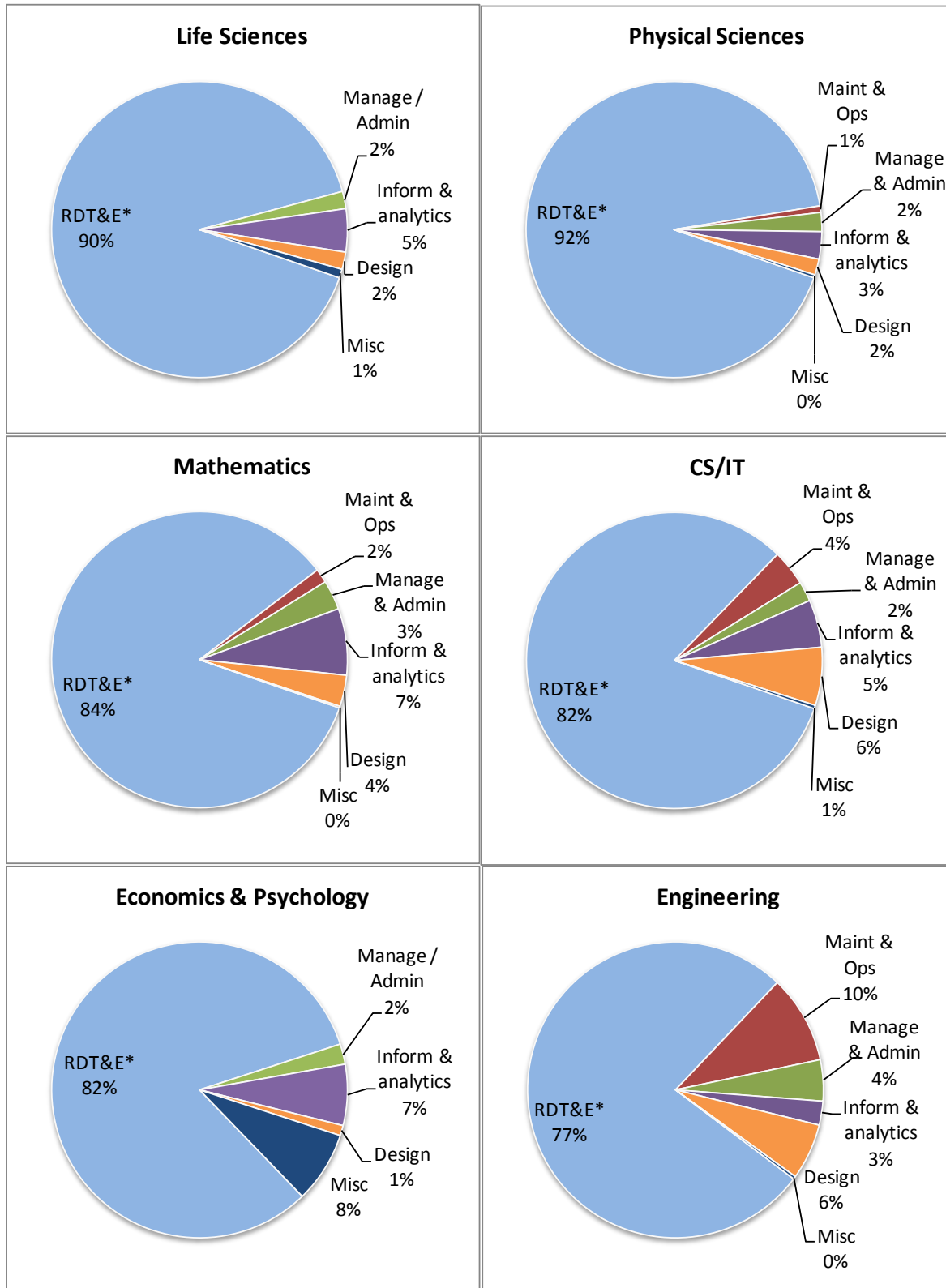
Figure 12 drills down to greater detail within the large RDT&E function in Figure 11. Nearly 60 percent of PhDs are involved in research with less than 10 percent in test and evaluation. Master's degree holders in the Navy Labs technical workforce are the most likely to be in development, while bachelor's degree holders are the most likely to be in test and evaluation.



**Figure 12. Distribution across RDT&E by Degree Level, Navy Labs Technical Workforce**

Figure 13 shows the functions for members of the Navy technical workforce based on broad occupational group. Life and physical scientists are most likely to be in RDT&E and engineers, whose work functions are the most heterogeneous, are least likely to be doing jobs that are characterized as RDT&E.

<sup>9</sup> The only comparable national technical workforce data are from the NSF's Scientists and Engineers Statistical Data System (SESTAT). At this time, only 2008 data are available; 2010 data should be available in early 2014. Also, there were a total of 4,721 Navy Labs technical workforce members (18 percent) who had not been assigned function codes. Of these, 1,236 also had less than a bachelor's degree. Figure 11 also does not include the 103 Navy Labs technical workforce members who had less than bachelor's degree but had been assigned a functional code.



*\*Note: RDT&E refers to work functions and not the RDT&E appropriation.*

**Figure 13. Work Functions of Navy Technical Workforce by Broad Occupational Group**



## 4. Navy Labs Mission Critical Occupations (MCOs)

The DoD Strategic Workforce Plan has identified Mission Critical Occupations<sup>10</sup> (MCOs) for DoD, of which the following are within the Navy Labs technical workforce:

<u>Occupation</u>	<u>Number</u>	<u>Occupation</u>	<u>Number</u>
840: Nuclear engineering	4	180: Psychology	106
854: Computer engineering	1,346	1550: Computer science	2,726
855: Electronics engineering	7,353	2210: Information Technology Mgmt	2,439

This section focuses on the four largest Navy Labs MCOs, which together account for 13,864 members (53.4 percent) of the Navy Labs technical workforce. The Navy labs employ just 4 civilians in series 840: nuclear engineering, yet this is a MCO because there are ~2,160 DoD civilian employees in this specialized occupational series. Almost all of the civilians employed in 840: Nuclear engineering are with either the Atlantic or Pacific fleet (~2050) with an additional ~110 at the Naval Sea Systems Command. Nearly half (47.4 percent) of series 840: Nuclear engineers perform maintenance and operations functions. The final MCO is series 180: Psychology. While the majority of the Navy Labs psychologists are in RDT&E, across the DoD most individuals in this occupational series have “Clinical practice, counseling, and ancillary medical” as their primary function, so consequently, this series is included in the medical functional community by OUSD(P&R).

### **Mission Critical Occupations**

Occupations agencies consider core to carrying out their missions. Such occupations usually reflect the primary mission of the organization without which mission-critical work cannot be completed.

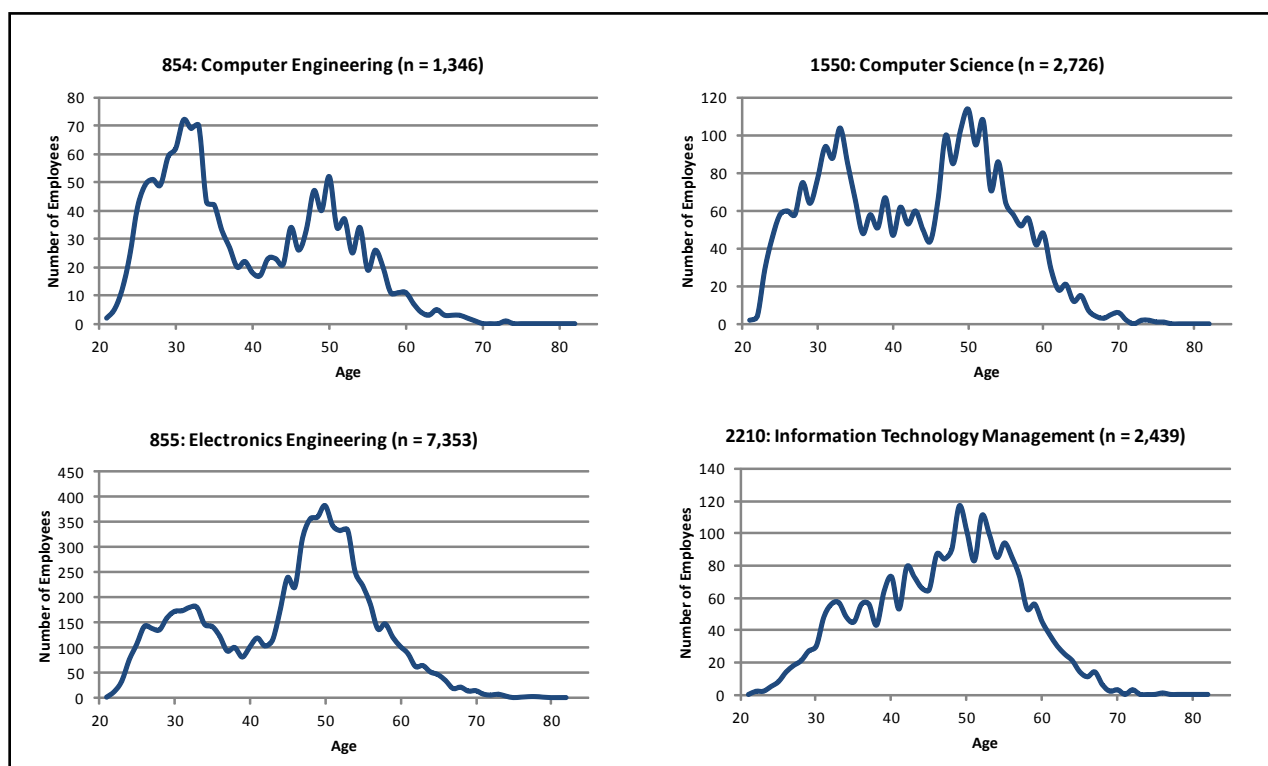
### 4.1 Description of Navy Labs Technical Workforce in Four MCOs

The age profiles for the four MCOs are shown in Figures 14 and 15. Figure 14 shows age distributions for each occupation; note that the scale on each y-axis differs because of the different numbers of individuals in each of these four occupations. Figure 15 juxtaposes pairs of these four occupations in the population pyramid format used earlier in this report.

The age profiles of these four occupations differ greatly, as shown in Figure 14, which may reflect on-going changes in the nature of work and the skills required for the Navy Labs technical workforce. The juxtaposition in Figure 15 provides a way to shed light on these issues. In the top panel, both series 855: Electronics and series 854: Computer engineering have a “dip” in the two age groups representing mid-career employees aged 35-44. In contrast, the computer engineering workforce is more skewed towards the younger end of the age spectrum, while the electronics engineering workforce is skewed towards the older end, perhaps indicating that the skillsets of past electronics engineers are now being replaced with those of computer engineers.

<sup>10</sup> As defined by the U.S. Office of Personnel Management “Human Capital Management Reference Materials Glossary” accessed online at <http://www.opm.gov> on September 27, 2013.

A more in-depth analysis of these occupational series and their work is needed to confirm this hypothesis.



**Figure 14. Age Distributions, Navy Labs Technical Workforce MCOs**

The right side panel compares the information technology (IT) and computer science (CS) workforces. The IT workforce does not feature the same mid-career “dip” like the other three MCOs and, indeed, is a more senior workforce. The CS age distribution bears some resemblance to the other MCOs (i.e., is bimodal).

Figure 16 shows that a sizable portion (43 percent) of the Navy Labs electronics engineering workforce is either eligible now or will be eligible to retire within the next five years. This rate exceeds that of the Navy Labs overall rate of 35.5 percent.

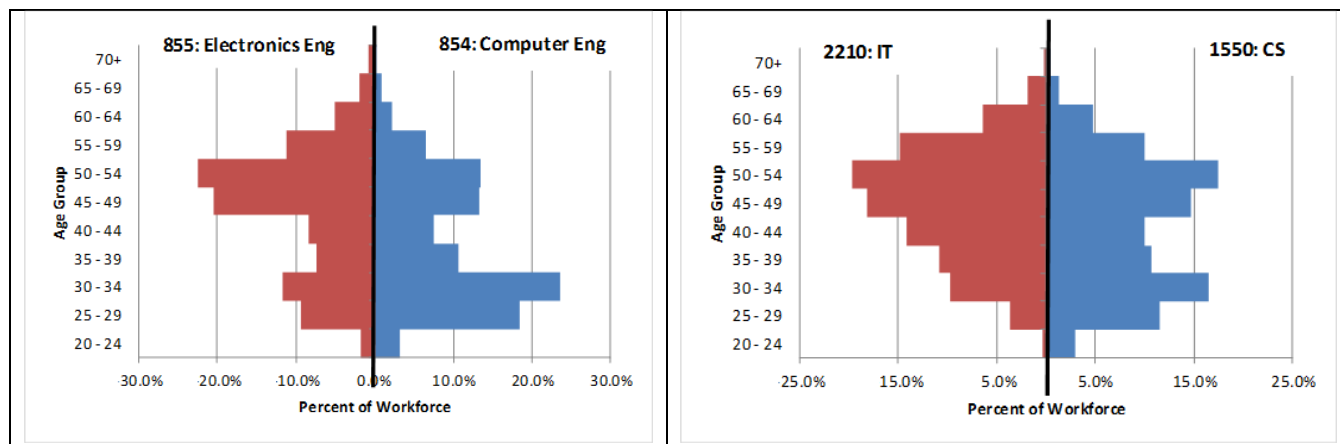


Figure 15. Age Distributions: Navy Labs MCOs

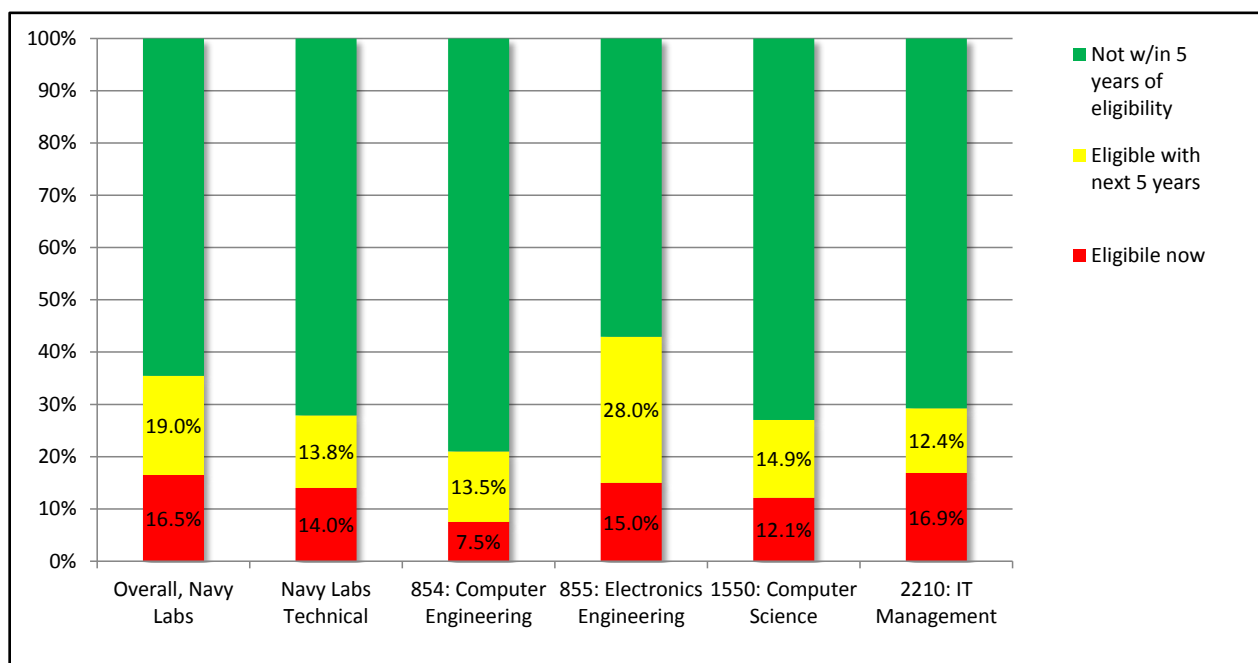
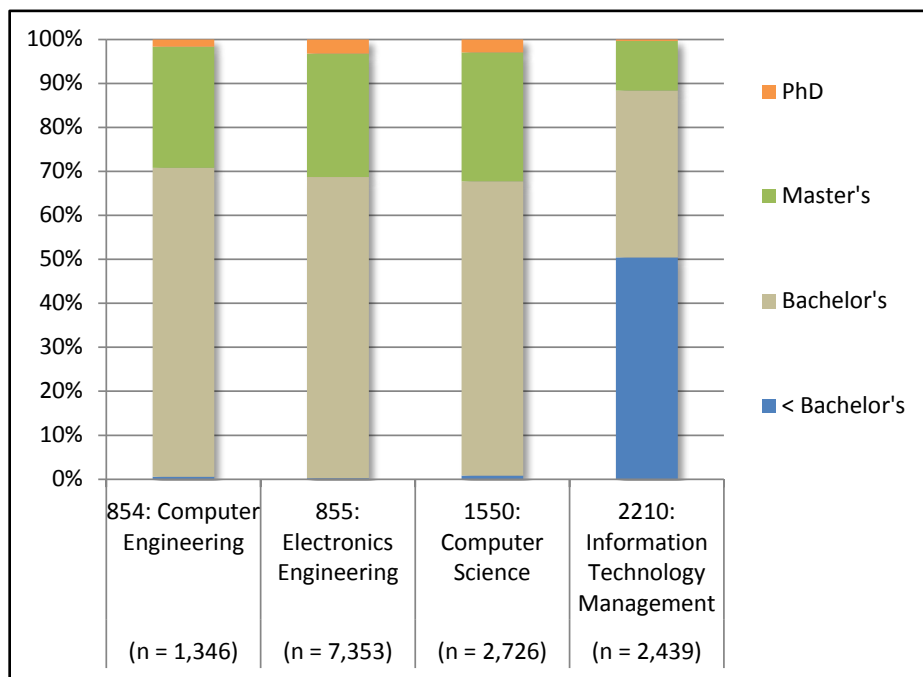


Figure 16. Retirement Eligibility, Navy Labs Technical Workforce MCOs, 2012

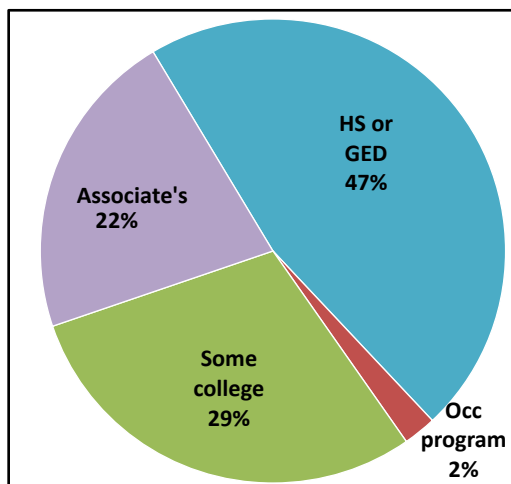
Figure 17 shows the educational backgrounds of the Navy Labs technical workforce in each of the four MCOs that are the focus of this section. Computer engineers, electronics engineers, and computer scientists share similar educational backgrounds; almost all have at least a bachelor's degree. Information technology is characterized by heterogeneous education levels, with half of the Navy Labs series 2210 occupants holding less than a bachelor's degree as their highest educational credential. Figure 18 provides details on the education of members of this latter MCO. Among the IT workers who have less than a bachelor's degree, 53 percent reported at least some postsecondary education.

Finally, Figure 19 shows the veteran's status of members of the Navy Labs workforce,

with a special emphasis on the four MCOs that have been featured in this section. Just about one-third of the full Navy Labs workforce has served in the military but this rate is much lower in much of the Navy Labs technical workforce. The principal exception, however, is 2210: IT management, in which 57.4 percent of workers are veterans. With the on-going draw-down in active duty strength, mechanisms to transition former military to civilian duties within the Navy could explore the underrepresentation of veterans among workers in the Navy Labs MCOs.

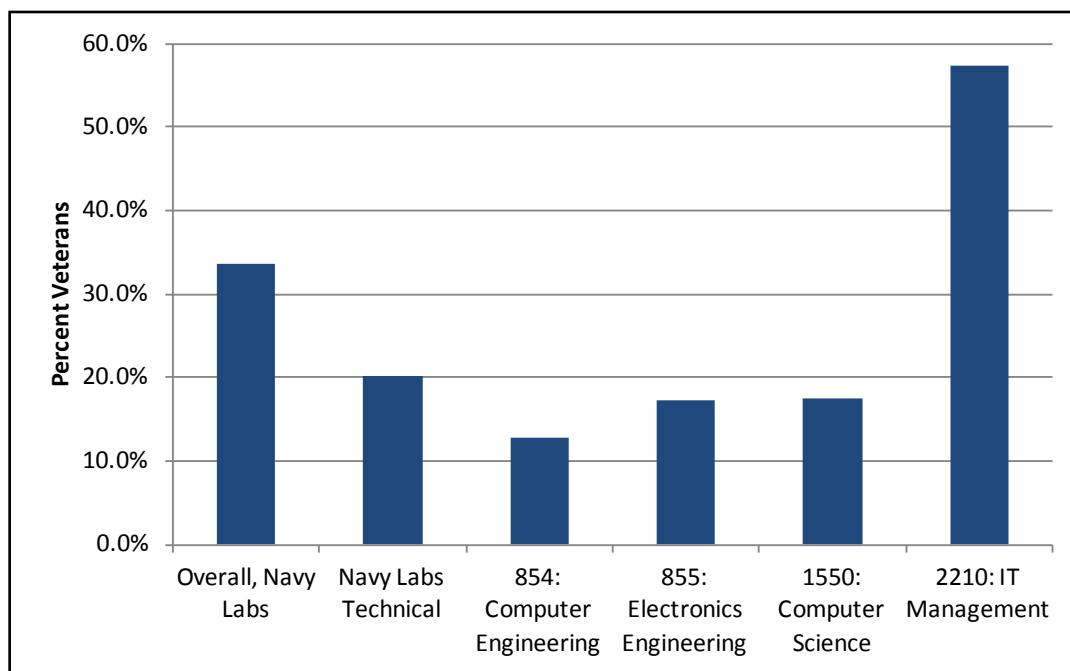


**Figure 17. Educational Backgrounds: Navy Labs MCOs, 2012**



**Figure 18. Educational Backgrounds for those in 2210: IT Management among those with Less than a Bachelor's Degree, 2012<sup>11</sup>**

<sup>11</sup> The "Occ program" label refers to "Occupational program," which are short postsecondary programs that may



**Figure 19. Veterans Status of the Navy Labs Workforce, 2012**

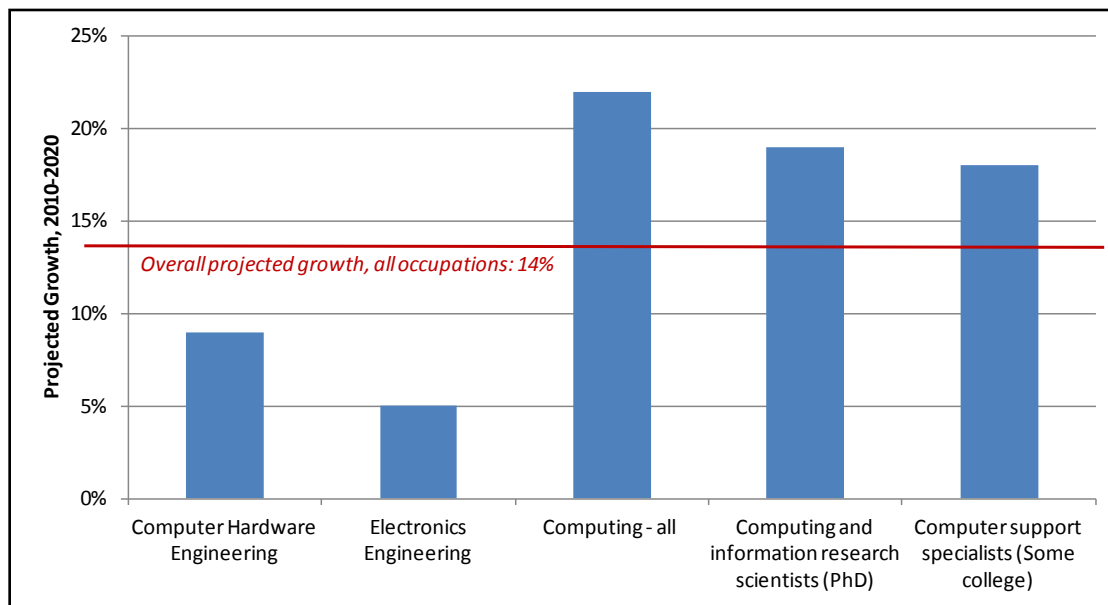
#### **4.2 Demand: BLS Projections, 2010-2020**

The national—indeed, international—labor market holds important implications for the Navy Labs technical workforce. The basic principles of supply and demand guide labor markets, affecting workers’ and employers’ behavior. Skills in short supply can produce a “seller’s market” that necessitates that employers assemble competitive compensation packages, which now include more than the traditional salary and benefits for recent graduation cohorts. Jobs with lower growth projections could have an exodus of workers: either new college entrants who choose to avoid these areas or layoffs of surplus workers, especially those who may not have maintained the currency of their skills. Institutions that prepare new workers may also be impacted as students avoid declining disciplines. It may become increasingly difficult to recruit faculty members, maintain specialized equipment, offer coursework within the curriculum, etc.

Figure 20 shows data from the BLS Occupational Outlook Quarterly on the percentage growth expected in the MCOs under consideration here within the context of projected overall job growth (14 percent, indicated by the red line in the graph). For illustration purposes, two of the ten detailed occupations included under the main BLS heading “Computer occupations” (labeled as “Computing-all”) are shown in Figure 20: “Computing and information research scientists,” who generally possess PhDs and “Computer support specialists” who typically have some post-secondary education but not, necessarily, a bachelor’s degree, as two ends of the spectrum for this rapidly-growing set of occupations.

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include a certification or other short-term award designation.



**Figure 20. BLS Workforce Projections, 2010-2020**

Computer hardware engineering and electronics engineering are projected to grow far slower than jobs in the rest of the economy at 9 percent and 5 percent, respectively. Labor force analysts have long focused on the “offshorability”<sup>12</sup> of these positions. As offshorability increases, the incentives—typically personnel costs, but also various regulatory incentives—for industries to move operations offshore increases. The Federal government is a key employer of individuals in these occupations, likely due to the security needs of maintaining U.S. citizens in these positions. That is, while private industry has increasingly offshored these key engineering positions, Navy Labs and other Federal employers have worked to maintain a domestic labor supply. Just as nuclear engineering programs suffered from declining enrollments through the 1980s, it remains to be seen what the long-term implications of offshoring will be for the U.S. educational infrastructure to prepare individuals with the electronics engineering skills needed by the Navy Labs. It could be useful for ONR to identify specific bachelor’s and master’s degree programs at U.S. colleges and universities that emphasize the electronics engineering specialty within electrical engineering to ensure access to students with the requisite skills to complete Navy Labs work.

Computing occupations, on the other hand, are some of the most rapidly growing jobs according to the BLS projections. Overall, computing jobs are slated to increase by 22 percent

<sup>12</sup> According to Blinder and Krueger (2009), the characteristics of jobs that are highly offshorable include: Extensive use of computers/email; Processing information/data entry; Talking on the telephone; Analyzing data; Assembling or packaging a product. Based on these characteristics, Blinder and Krueger suggest that electronics engineering is “highly offshorable.” For additional background on offshoring, see also: Committee on the Offshoring of Engineering. (2008). *The Offshoring of Engineering: Facts, Unknowns, and Potential Implications*. (Washington, DC: National Academies Press).

with robust growth among nearly all types of computing occupations. BLS projects that the United States will need an additional 19 percent doctoral-degreed computer and information research scientists by 2020 (versus the number employed in 2010) and an additional 18 percent computer support specialists in that same timeframe. Although the BLS *Occupational Outlook Handbook* indicates that the majority of computing jobs require a bachelor's degree, it is unclear that this is necessarily true<sup>13</sup> and whether the degree must be in computing or if college-educated individuals from a range of fields would be suitable for employment in these occupations.

#### **4.3 Supply: Degree Trends in Electronics Engineering, Computer Engineering and Computer and Information Sciences**

Three issues with degree trends in electronics engineering<sup>14</sup>, computer engineering, and computer and information sciences suggest that meeting the needs for the Navy Labs computing technical workforce could become increasingly challenging in the coming years.

- 1) Trends in bachelor's degrees awarded in computer and information sciences;
- 2) Demographic change in overall bachelor's degree production compared to the "feeder fields" for the Navy MCOs; and
- 3) Trends in representation of U.S. citizens<sup>15</sup> among doctoral degrees in these three fields.

Figure 21 shows the number of bachelor's and master's degrees awarded to U.S. citizens and foreign students in computer and information sciences between 1987 and 2011. In 2004, at the peak of degree production, 54,908 degrees were awarded but in the most recent year for which these data are available (2011) just 41,558 bachelor's degrees were awarded. BLS projects that by 2020 there will be an additional 631,200 positions in computing/information technology (CS/IT) for which a bachelor's degree is the normative educational credential; in contrast the economy will include 156,200 more engineering jobs by 2020. U.S. colleges and universities are likely to produce about 455,000 bachelor's degrees in computer and information sciences and nearly 800,000 bachelor's in engineering between 2010-2020<sup>16</sup>. While the current rate of production applied forward in engineering may satisfy the BLS projected needs for engineers, a gap for CS/IT workers is likely to remain. And, it is not clear without further study, whether the

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<sup>13</sup> See, for example, a report by the American Association for the Advancement of Science (2005) "Preparing Women and Minorities for the IT Workforce."

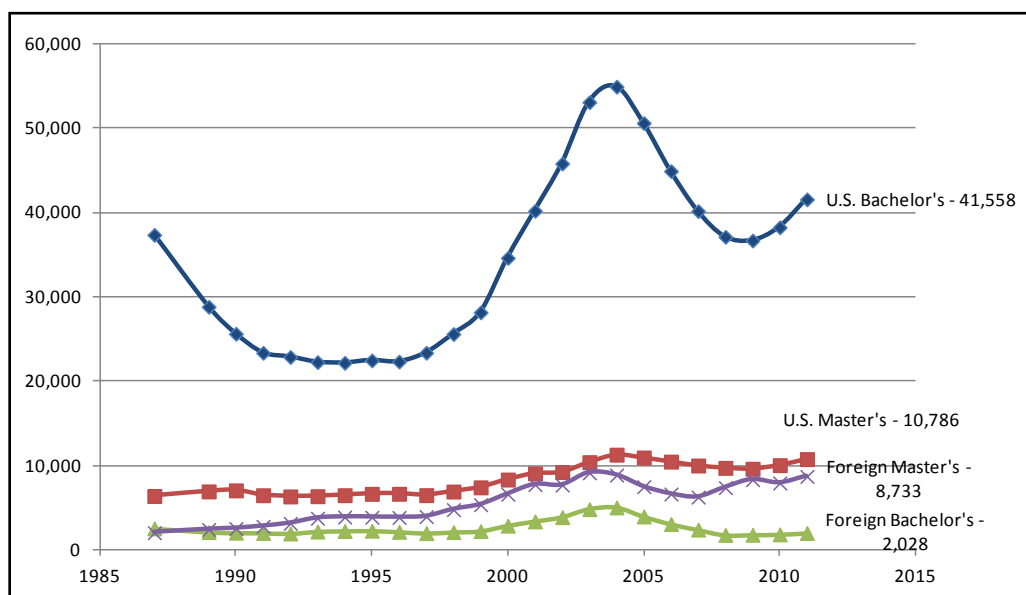
<sup>14</sup> Data reported by U.S. government sources on degrees does not disaggregate electronics engineering from "Electrical, electronics, and communications engineering." While students trained in electrical engineering may be sufficiently versatile to work in electronics, the offshoring of electronics engineering may have resulted in less emphasis on this area in U.S. electrical engineering programs.

<sup>15</sup> U.S. citizens includes permanent residents, which is relatively small and is not broken out in U.S. government statistical reporting about enrollment and degree trends.

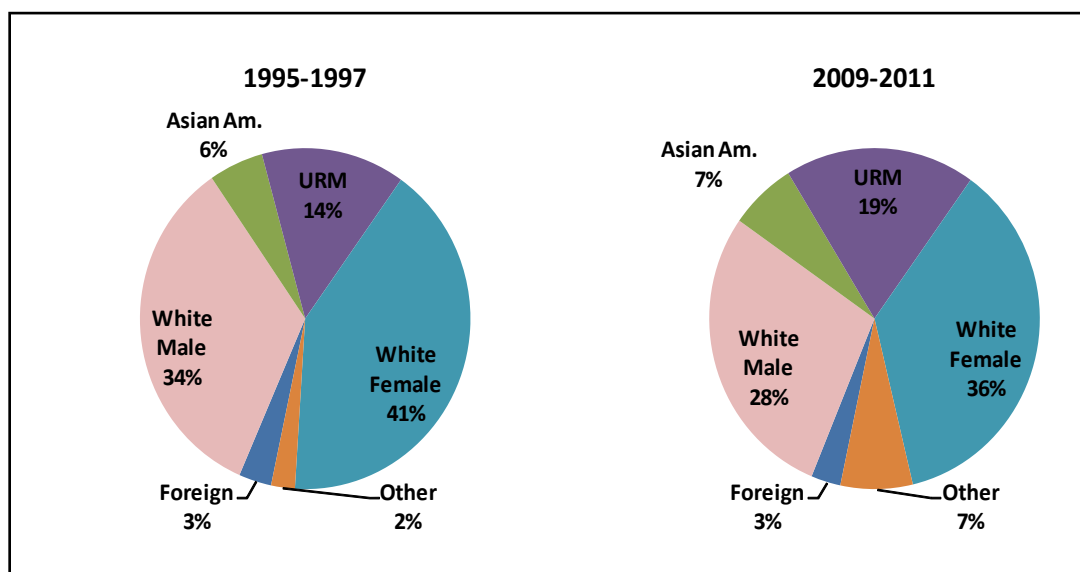
<sup>16</sup> These estimates are based on a simple linear estimation method applying the current rates of degree attainment for U.S. citizens by race/ethnicity and gender, to expected numbers of students graduating through 2020 in computing and engineering. This linear estimation method does not account for potential impacts of targeted interventions designed to increase U.S. students' interest and persistence in these fields, taking current participation rates by race/ethnicity and gender as constant.

specific preparation of electrical engineering students in U.S. colleges and universities includes sufficient attention to electronics to satisfy the Navy Labs on-going need for this skillset.

The long-term demographic changes in the U.S. population also pose important implications for the degree fields that supply graduates for four of the Navy Labs MCOs. Since the 1970s, the share of women and minorities among bachelor's degree recipients has increased greatly, yet participation of these groups in the three fields—computer engineering, electrical engineering, and computer and information sciences—has not kept pace with these changes.



**Figure 21. Trends in Bachelor's and Master's Degrees in Computer and Information Sciences Awarded by U.S. Colleges and Universities, 1987-2011**



**Figure 22. Bachelor's Degree Demography, Three-Year Totals 1995-1997 and 2009-2011<sup>17</sup>**

<sup>17</sup> Except for the wedges labeled "foreign," all other segments of both charts are U.S. citizens and permanent



Figure 22<sup>18</sup> shows that during the 1995-1997 period, white males accounted for 34 percent of bachelor's degrees in all fields but that their representation had declined by 6 percentage points by 2009-2011. Likewise, white females' share of bachelor's degrees declined by 5 percentage points over this period even as white females continued to represent a larger share of bachelor's graduates than white males. Underrepresented minorities (URMs, which includes American Indians and Alaska Natives, African Americans and Hispanics) have represented an increasing share of bachelor's degrees, even though this growth has not matched the general population growth of, especially, Hispanics. The "other" category, which includes individuals who indicate multiple racial categories or who do not report any racial category, has grown and is projected to account for an increasing share of young people for a variety of reasons. In short, in 2009-2011, 72 percent of all bachelor's degrees were awarded to people who were not white males.

Figure 23 shows the demographic composition of bachelor's degree awardees in 1995-1997 and 2009-2011 for the three fields that supply four of the Navy Labs technical workforce MCOs. White male representation in these fields still far exceeds the white male share of all bachelor's degrees. URM representation in computer engineering and in computer and information sciences has increased between the first three-year period (1995-1997) and the most recent three-year period, 2009-2011.

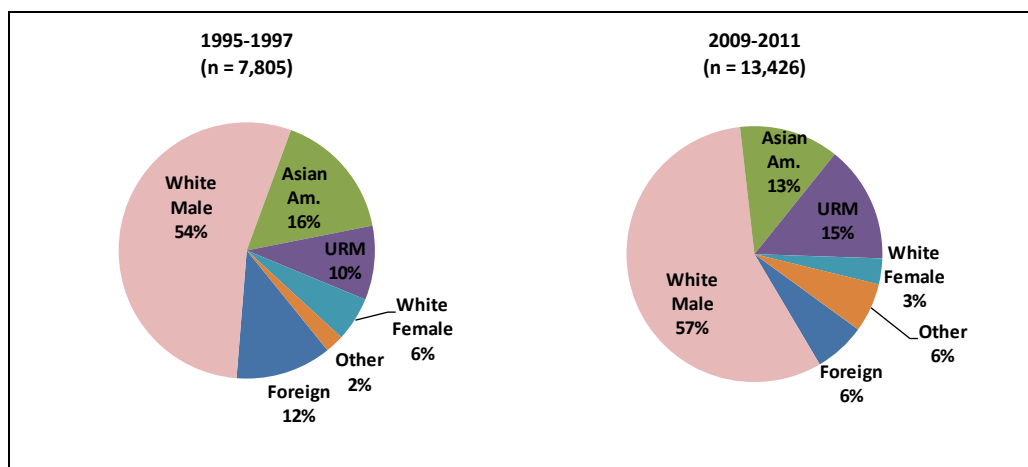
It should also be noted that between 1995-1997 and 2009-2011, the number of bachelor's degrees increased modestly in computer engineering and computer and information sciences, but declined by more than 7,500 degrees (an average of 2,500 a year) in electrical, electronics and communications engineering. The distribution of degrees in this latter field has remained fundamentally unchanged over that period. White females' proportionate participation in both computer and information science and computer engineering have declined; although not shown here, participation in these majors by women in other U.S. race/ethnic groups have similarly declined.

The final supply issue concerns the "upper end" of the educational continuum: the relative representation of U.S. citizens among recipients of doctoral degrees, which has declined for all three degree fields since 1995. U.S. citizens in the two engineering fields (electrical and computer) account for less than 40 percent of PhDs awarded by U.S. colleges and universities. In computer and information science, U.S. citizens most recently earned about half of all PhDs. The most recent year for which data are available is 2011. The most recent three-year average number of degrees, shown in the right-side panel of each of the three sections of Figure 24, shows that there were 114 U.S. citizen PhDs in computer engineering, 647 in electrical, electronics, and communications engineering and 761 in computer and information science.

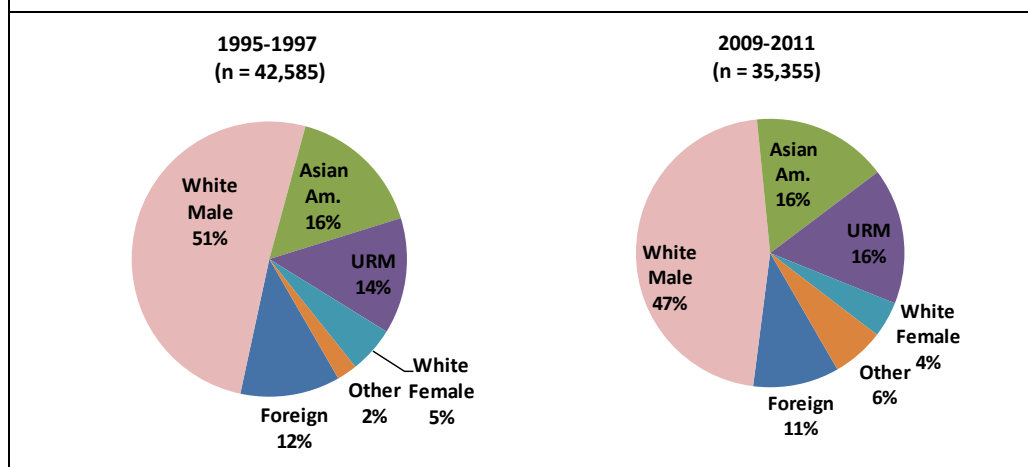
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residents.

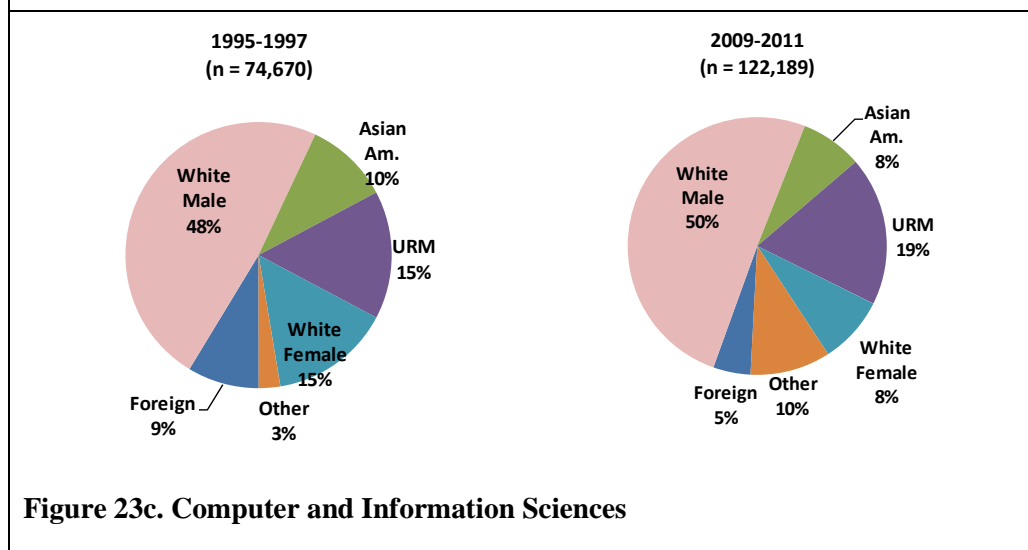
<sup>18</sup> Not all of the 14 possible race/ethnicity by gender groups are shown in the degree charts for the sake of simplicity. Expanded data are available for all groups upon request.



**Figure 23a. Computer Engineering**



**Figure 23b. Electrical, Electronics, and Communications Engineering**



**Figure 23c. Computer and Information Sciences**

**Figure 23. Demography of Bachelor's Degrees in Fields Supplying Navy Labs MCOs, Three-Year Totals 1995-1997 and 2009-2011**

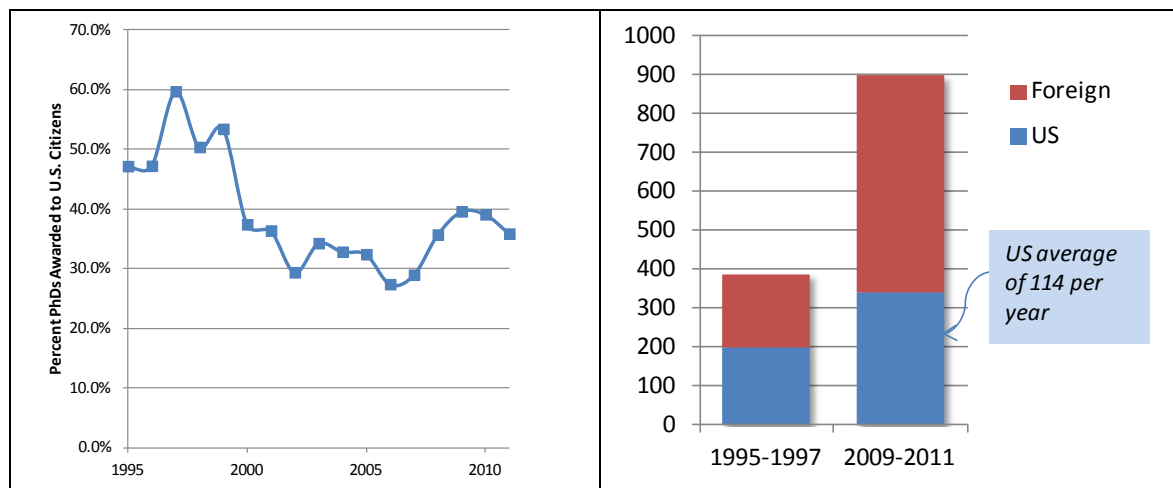


Figure 24a. PhD Degree Trends in Computer Engineering, 1995-2011

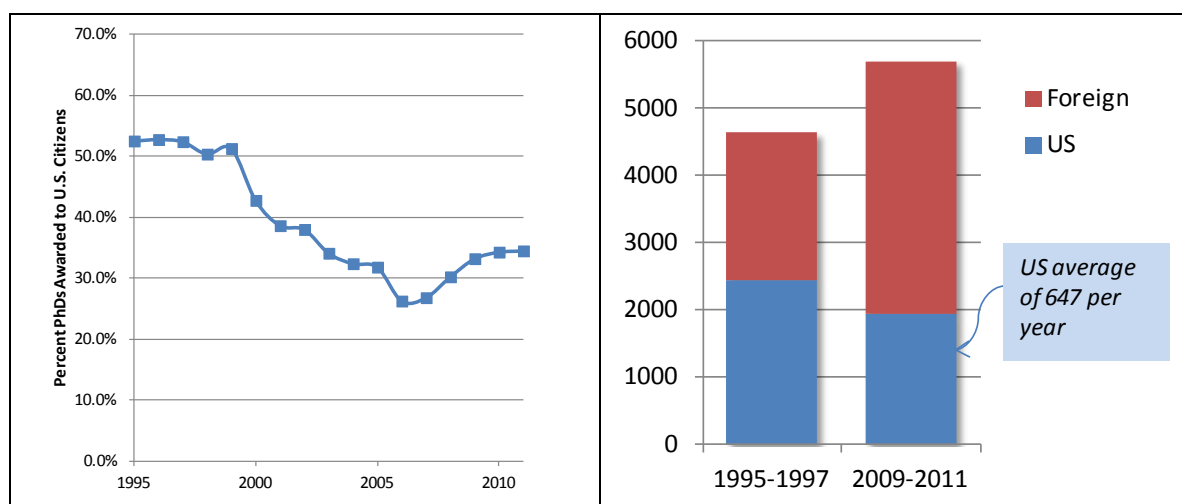


Figure 24b. PhD Degree Trends in Electrical, Electronics, and Communications Engineering, 1995-2011

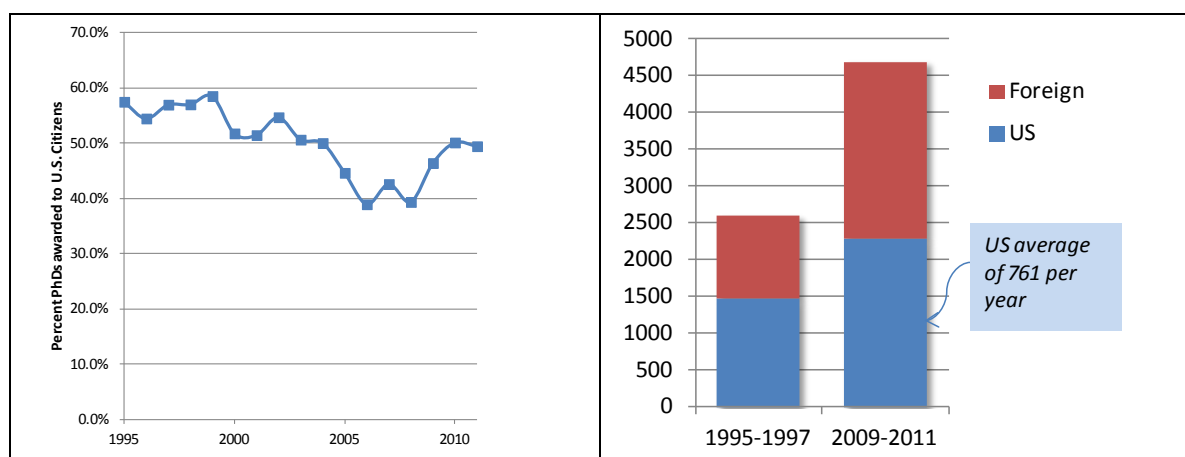


Figure 24c. PhD Degree Trends in Computer and Information Science, 1995-2011

## 5. Summary and Suggested Strategies

### 5.1 Summary

This report has shown the Navy Labs technical workforce within the context of the national technical workforce. Whereas the technical occupations included in these analyses accounted for just 4.7 percent of the national workforce, these same jobs comprised 57.6 percent of those employed at the Navy Labs. In addition, this workforce is heavily weighted towards engineers—67.8 percent of the Navy Labs technical workforce—versus computer science and information technology jobs that comprise 54.1 percent of the national technical workforce.

The Navy Labs technical workforce is skewed towards more senior-career workers, but this tendency varies across the six broad occupational groups analyzed in this report. While the life scientists and economists and psychologists employed by Navy Labs are from earlier career age groups, the physical sciences and CS/IT workforces, in particular, are more heavily weighted towards the older age groups. Overall, 27.8 percent of the Navy Labs technical workforce is eligible to retire now or within the next five years.

Overall, the race/ethnicity and gender composition of the Navy Labs workforce is not substantially different from the national technical workforce; yet the differences shown in this report should bear on-going observation, with special attention within the CS/IT degree fields and occupations, given the growth of these in the national technical workforce and the demographic supply issues shown in Section 4 of this report. Addressing the underrepresentation of these groups in the fields of interest to the Navy Labs has been a matter of public concern and is the fourth goal of the *Federal STEM Education 5-Year Strategic Plan*<sup>19</sup>. Women's representation in the Navy Labs technical workforce is reflected in the age profiles of the six occupational groups, with the “younger” groups (e.g. life sciences) reflecting current degree production trends and the “older” groups (e.g., physical sciences) reflecting historic degree production and hiring practices.

Salaries do not appear to lag those outside Navy Labs but there were many caveats in the salaries analysis, therefore, this conclusion should be taken with caution. Recent observers of hiring trends indicate that the “net generation” have more expansive expectations for a total compensation package that goes beyond good pay and benefits to include work/life balance and workplace climate considerations.<sup>20</sup> Work by the Partnership for Public Service has highlighted the strategies Federal employers will need to implement to compete for the best new talent.<sup>21</sup>

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<sup>19</sup> The Federal STEM Education 5-Year Strategic Plan can be obtained online at: [http://www.whitehouse.gov/sites/default/files/microsites/ostp/stem\\_stratplan\\_2013.pdf](http://www.whitehouse.gov/sites/default/files/microsites/ostp/stem_stratplan_2013.pdf).

<sup>20</sup> See, for example, Chief Information Officers Council. (April, 2010). “Net Generation: Preparing for Change in the Federal Information Technology Workforce” (Washington, DC). See also: National Association of Colleges and Employers (NACE). (2013). “2013 Internship & Co-op Survey” (Bethlehem, PA).

<sup>21</sup> Three publications from the Partnership for Public Service are helpful: (1) “Best Places to Work in the Federal Government Analysis: Diversity and Inclusion” (June, 2013); (2) “The Best Places to Work in the Federal Government: 2012 Rankings” (2012); and (3) “The Biggest Bang Theory: How to get the most out of the competitive search for STEMM talent” (2013), all of which are accessible online at <http://ourpublicservice.org/OPS/publications/>.

The Navy Labs technical workforce is highly educated compared to the national technical workforce and the Navy Labs total workforce: 94.8 percent hold a bachelor's degree or higher; 35.3 percent hold master's degrees or PhDs compared to 27.8 percent of the national technical workforce. Not surprisingly, the Navy Labs technical workforce is heavily concentrated in research, development, test and evaluation work ranging from 77 percent of those with bachelor's degrees to 91 percent of PhD employees. Engineers' functions are the most heterogeneous.

This report focused on four key occupational series that the OUSD(P&R) Strategic Workforce Plan has identified as "Mission Critical Occupations:" Series 854: Computer engineering, Series 855: Electronics engineering, Series 1550: Computer science and Series 2210: Information technology (IT) management. Together, the 13,864 employees in these four occupational series account for 53.4 percent of the Navy Labs technical workforce. Several key points emerged from this analysis:

- Electronics engineers are highly skewed towards the older age-groups and 43 percent of these employees are eligible to retire now or within the next five years.
- IT management is also a relatively senior workforce, in stark contrast to IT workers in the national technical workforce.
- The IT management workforce differs in two important ways from the other three MCOs and the Navy Labs technical workforce in general: (1) half of these workers have an educational credential below a bachelor's degree but of these, 53 percent had completed some postsecondary education; and (2) 57.4 percent of the Navy Labs IT workers are veterans as compared to just 20 percent of the overall Navy Labs technical workforce.
- BLS projections suggest that future recruitment and retention of CS/IT workers could be challenging for the Navy Labs due to possible shortages of talent produced by U.S. colleges and universities.
- At the PhD level, the declining representation of U.S. citizens in the three disciplines that feed the Navy Labs MCOs may make recruitment of new workers at this level challenging.
- Electronics engineering has been subject to offshoring in the larger economy; the implications of globalization, combined with the large impending retirement wave for Navy Labs electronics engineers suggest a need to more carefully examine this field.

## 5.2 Suggested Strategies

Our suggestions focus on strategies to strengthen the current Navy Labs technical workforce to address the challenges of recruiting and retaining a future workforce. In addition it is suggested that on-going workforce analyses of the types completed in this report be completed every three years, with additional studies to focus on workforce attrition and to look at specific occupational series.

*Consider establishing a “retooling” program for the existing Navy Labs workforce to grow the requisite technical skills among current employees.*

As the shuttle program ended, NASA developed a retooling program so that the existing workforce would be able to shift to other space programs. By retaining employees, the learning curve was not as steep as if all new employees were hired, and the existing organizational knowledge base proved important to increasing efficiency and effectiveness of the workforce. Such programs could feature cooperative agreements with Defense Industrial Base contractors so that Navy Labs employees could complete short-term assignments at outside firms. Similar arrangements with other national labs (especially, for example, Department of Energy labs) could also provide opportunities for Navy Labs employees to refine and update skills and learn new equipment and methods.

Navy Labs technical workers with doctoral degrees could be detailed to colleges or universities to collaborate with researchers and to teach in the classroom. The latter experience would more directly connect such personnel to new students, new ideas, and new research in their field.

*Investigate the extent to which U.S. college and university electrical, electronics and communications engineering programs include sufficient course material in electronics engineering.*

The Navy relies upon a large number of electronics engineers to perform a variety of functions in its technical workforce. In the U.S. labor force, though, electronics engineering work is considered highly offshorable, which means that this skillset is increasingly less relevant to the U.S. as the work is sent abroad. There are, therefore, questions about the potential implications of offshoring for the postsecondary educational programs in electrical, electronics and communications engineering: will these programs continue to feature sufficient electronics engineering content to meet the skills needs of the Navy Labs?

A study needs to start with a careful examination of the work that computer engineers and electronics engineers do in the Navy Labs. Recall the age distributions shown in Figure 15 in which both series 855: Electronics and series 854: Computer engineering had a “dip” in the two age groups representing mid-career employees aged 35-44. Whereas the computer engineering workforce was more skewed towards the younger end of the age spectrum, the electronics engineering workforce was skewed towards the older end, perhaps indicating that the skillsets of past electronics engineers are now being replaced with those of computer engineers. A more in-depth analysis of these occupational series and their work is needed to confirm this hypothesis

and to determine whether U.S. electrical, electronic and communication engineering programs are meeting the needs for the Navy Labs technical workforce.

*Consider additional formal partnerships with relevant organizations to increase the participation of women and groups historically underrepresented in computing and engineering to ensure a robust domestic supply of future workers with skills in these fields.*

Currently, the Navy Labs technical workforce has a diversity profile that is quite similar to that of the national technical workforce, but the latter workforce does not reflect the diversity of U.S. youth. This is not specifically a “Navy problem,” but one of national scope that, as highlighted in the new Federal STEM Education 5-Year Strategic Plan, will require collaborative effort by government, industry, and academia to solve. Non-profit professional organizations such as the Society of Women Engineers (SWE), the National Center for Women and Information Technology (NC-WIT), the National Society of Black Engineers (NSBE), the Society for Hispanic Professional Engineers (SHPE), the National Action Council for Minorities in Engineering (NACME), the Association for Computing Machinery (ACM), and the Institute for Electrical and Electronics Engineers (IEEE) are all involved in increasing access to engineer and computing educational opportunities and careers for women and individuals from groups historically underrepresented in these fields. Internships and co-ops could be used to recruit more diverse students to the Navy Labs technical workforce. Research by the National Association of Colleges and Employers (NACE) and the Partnership for Public Service (PPS) indicates that such internships and co-op positions, need to have high-quality mentoring and work assignments in order to increase the likelihood that interns and co-op students will accept post-graduation employment offers.

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## **Addendum**

“Report on Navy Laboratory and Warfare Center Demographics”

by

David M. Drumheller  
Office of Naval Research

James C. Meng  
Naval Sea Systems Command

27 September 2009

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IN REPLY REFER TO:

5314  
Ser 333/dmd/09-001  
27 Sep 09

From: Program Officer  
Sea Platforms and Weapons Division, Code 333  
To: Mr. James Thomsen  
Principal Civilian Deputy, Office of the Assistant Secretary of the  
Navy for Research, Development and Acquisition

Subj: REPORT ON NAVY LABORATORY AND WARFARE CENTER DEMOGRAPHICS

1. Enclosed is a written report on a demographic analysis of the technical workforce at the Naval Research Laboratory (NRL) and the warfare centers. Data for this analysis was provided by the Director, Acquisition Career Management (DACM).

2. The analysis derived demographic characteristics of the Navy's technical workforce and compared them to those of a comparable subset of the national workforce. It was found that the Navy's workforce is demographically and professionally uneven, with an excess of late-career workers, high male-to-female ratios and a mix of technical skills not well-matched to those doing similar work in the general economy. Recommendations for rebalancing the workforce are included.

3. I recommend this analysis be performed annually and the results forwarded to the Navy Laboratory/Center Coordinating Group (NLCCG). To that end, the attached report was prepared to provide adequate documentation to repeat the analysis with new data. Additionally, I am negotiating with the Energetics Technology Center (ETC) to 1) perform the demographic analysis next year and 2) prepare the Fiscal Year 2009 Management Analysis Report to the NLCCG. Funds to support these efforts are available at the Office of Naval Research (ONR).

*David M. Drumheller*  
DAVID M. DRUMHELLER

Enclosure: Report

Copy to: R. Carlin, ONR 33  
K. Ng, ONR 03R  
K. Jenne, ONR 03R  
S. Millik, ONR 03R

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# Navy Laboratory/Warfare Center Age, Wage and Occupational Characteristics

David M. Drumheller<sup>1</sup> and James C. Meng<sup>2</sup>

10 September 2009

## 1. Introduction

This report provides a demographic snapshot of the scientists and engineers (S&Es) employed at the Naval Research Laboratory (NRL) and Navy warfare centers and compares it to a workforce comprised of S&Es of similar occupations within the general economy, which shall be referred to as the “national technical workforce.” No distinction was made between the Navy’s science and technology (S&T) workforce, which is support by 6.1 through 6.3 budget activity funds, and the acquisition workforce, which is supported by funds from higher budget activities. Rather, both types of workers were included in a single group referred to as the “Navy technical workforce.”

The workforces were sub-divided into five academic disciplines: Life Science (LS), Physical Science (PS), Engineering (ENG), Mathematics and Information Science (M&IS) and Social Science (SS). Overall, the analysis shows the Navy technical workforce is comprised mostly of engineers, is male-dominated and exhibits uneven demographics with an excess of late-careers workers and a dearth of mid-career workers. It is also found considerable spread in the median ages among the disciplines, with life scientists being the youngest and the physical scientists being the oldest.

Data used in this analysis, which is described in Appendix A, was provided by the Department of the Navy, the Bureau of Labor Statistics (BSL) and Office of Management and Budget (OMB). Appendix B describes how the technical workforces were defined with respect to Federal Civil Service General Schedule (GS) Occupational Series and BLS-defined occupations.

## 2. Analysis of Workforce Data

### 2.1 Overall Age Distribution

Figure 1 shows age distributions (histograms) for the national total workforce and the Navy technical workforce, with the later showing a noticeable dip in the 35-to-40 age bin and a prominent peak in the 45-to-49 age bin.

Figure 2 shows age distributions for the national technical workforce and the Navy technical workforce. Because of the ten-year age range for all but the first bin, which is a limitation imposed by BLS data sets, there is no pronounced dip in the 35-to-44-year bin. Nevertheless, it still reveals a peak for late-career workers.

Ideally, these distributions should be flat between the early twenties and mid fifties, which is essentially the case for the national workforces, but clearly not the case for the Navy technical workforce. If nothing is done, time alone will provide some relief from this problem,

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because over the next decade, those within the late-career peak will begin to retire from civil service. However, this will have the consequence of putting the group ten years behind them in a position to assume responsibilities quickly, possibly without the necessary professional seasoning.

## **2.2 Distribution by Academic Discipline**

Figure 3 shows distributions of the Navy and national technical workforce (two definitions) among five academic disciplines defined by Coffey.<sup>3</sup> Appendix B describes how the various GS Occupational Series and BLS-defined occupations are grouped within these disciplines.

The figure reveals the same mismatch between these workforces cited by Coffey who showed that within the 2000 national technical workforce, there was essentially parity between engineers and information scientists. Coffey also claimed that the last time the composition of the national technical workforce was like that of the current Navy workforce was in 1990, nearly twenty years ago.

The figure also clearly shows those classified as engineers are by far the largest group. Of this group, 46 percent are classified as electronic engineers (Series 0855). There are similar majorities within the other disciplines. Among the physical scientists, 59 percent are physicists (Series 1310). Among mathematicians and information scientists, 68 percent are computer scientists (Series 1550).

## **2.3 Age Distribution within Academic Discipline**

Figure 4 shows age distributions of the Navy technical workforce for each academic discipline. Of note is the skewing of the Life Sciences histogram toward the left (younger) and the one for Physical Sciences to the right (older).

Figures 5 through 9 compare the demographics of academic groups for the Navy and the national technical workforce. Generally, these figures show that for each discipline, there is some manner of mismatch between comparable groups within national and Navy workforces.

Although not shown here, comparisons between more narrowly defined groups such as electrical and electronics engineers, mechanical engineers or physicists also show age distribution mismatch between the Navy and national technical workforces.

## **2.4 Gender Ratio**

Figure 10 shows the male-to-female ratio by each academic discipline for the Navy and national technical workforces. Only in the life sciences does the Navy technical workforce approach parity between genders, a condition reflected in the national workforce. On the other hand, the ratio for the physical sciences is twice that of the national technical workforce. Overall, the Navy technical workforce is male-dominated, even more so than the national technical workforce.

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<sup>3</sup> Timothy Coffey, *Building the S&E Workforce for 2040: Challenges Facing the Department of Defense*, National Defense University Defense and Technology Paper, July 2008

## 2.5 Hiring Rate

Figure 11 shows the estimated hiring rate for the Navy technical workforce since 1970, which is based on the date of hire for each employee listed in the Navy data set. Also shown are defense outlays over the same period, which highly correlates with the hiring rate. Interestingly, if the curve for defense outlays is shifted to the left three years, the cross-correlation between the two curves is 0.85, suggesting that the hiring rate is a leading indicator of the defense budget. It is likely that out-year budget estimates available from the Future Years Defense Plan (FYDP) enables “anticipatory hiring.”

## 2.6 Salary

Figure 12 show average salary for each academic discipline for the Navy and national technical workforces. Overall, the figure suggests there is no great pay inequity between the two workforces.

Some caution is in order for interpreting this figure. Each bar represents an average over all age groups within a single academic discipline and therefore does not reveal any significant pay inequities that may exist at different career stages. It is also possible the previously noted demographic imbalances of the Navy technical workforce—an excess of late-career workers and high male-to-female ratios—may bias its average salaries toward higher values.

## 3. Summary

- The Navy technical workforce is demographically uneven, with an excess of late-career workers and dearth of mid-career workers.
- Navy physical scientists are the most elderly and the most male-dominated group. Overall, the Navy technical workforce is more male-dominated than the national technical workforce.
- The Navy technical workforce has an abundance of engineers, whereas in the national technical workforce, there are about as many engineers as there are information scientists. The mix of academic disciplines within the Navy technical workforce remains the same as it was during the Cold War.
- Hiring rates anticipate the defense budget (outlays) by three years.

## 4. Recommendations

The following two initiatives could rebalance the Navy technical workforce with respect to age and academic discipline:

1. Recruit mid-career workers from industry—now, not later—and provide those hired into management positions with remedial training to make up for their lack of government experience.<sup>4</sup> This initiative requires the creation of new billets.

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<sup>4</sup> The Naval Sea Systems Command/University Affiliated Research Center (NAVSEA/UARC) Human Resource Pipeline Program, a mid-career recruitment and training program, is intended to meet this goal and is jointly managed by NAVSEA and the Pennsylvania State University Applied Research Laboratory (ARL/PSU). Contact David Sivillo, (202) 781-3129, david.sivillo@navy.mil.

2. Reclassify billets of late-career workers as they retire. For example, for every three billets previously held by then-retired engineers, one could be reclassified as a mathematician or computer scientist. Within a decade, the result would be near parity between these two academic disciplines if no new billets are created.<sup>5</sup>

For the initiatives described above to be effective, there must be demographic goals to work toward. To establish these goals and develop strategies to meet them, the following studies are recommended:

3. Determine the proper mix of technical skills the Navy technical workforce should have a decade from now. The analysis here implicitly assumed that characteristics of the national technical workforce are ideal, or at least desirable. However, the Navy's portion of the military-industrial complex does not mirror the economy at-large, and so it may be unrealistic to expect the Navy's technical workforce to reflect the national technical workforce.
4. Determine why the Navy technical workforce is exceedingly male-dominated and develop recruitment strategies to attract women. The type of data useful for explaining the gender imbalance is perhaps best acquired through a survey. (There is likely an imbalance with respect to ethnicity that could be explained and, if necessary, remedied in a similar manner.)

Studies could be regularly performed to help set workforce revitalization benchmarks and track progress:

5. At the least, annually re-perform the analysis presented here and report the results to the Navy Laboratory/Center Coordinating Group (NLCCG). This should be easy to do, as the necessary data is readily available.
6. A more ambitious recommendation, but one that would provide more insight, is to annually perform demographic analyses of NRL warfare centers workforces, but compile separate results for the S&T and acquisition workforces within each institution. The distinction between could be made by defining the S&T workforce to be all workers billing 50 percent or more of their time to 6.1, 6.2 or 6.3 budget activity funds.<sup>6</sup> Such information is only available at the lab level.

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<sup>5</sup> At present, the ratio of ENG to M&IS disciplines within the Navy technical workforce is almost 5-to-1. This strategy would result in a ratio of 5-to-4, which is close to the ratio between these disciplines within the national technical workforce defined using BLS wage data.

<sup>6</sup> R.A. Kavetsky, M.L. Marshall and D.K. Anand, *From Science to Sea Power: A Roadmap for S&T Revitalization*, University of Maryland, College Park, MD, 2006, Chapter 6, endnote 2



## Appendix A: Data Sources

### A.1 Navy Data

Data on the technical workforce at the Naval Research Laboratory (NRL) and the Navy Warfare Centers was provided by the Director, Acquisition Career Management (DACM), Office of the Assistant Secretary of the Navy for Research, Development and Acquisition (ASN(RDA)). It included data on 21,397 workers at sites coded as follows:

- CARDEROCK DIV NS
- COASTSYSTA
- COMBAT DIRECTION SYS ACT DAM NECK
- CORONA DIV NAVAL SURFACE WARFARE CTR
- NAVAIRWARCENAC DIV
- NAVAIRWARCENADLKE
- NAVAIRWARCENWPNDIV CHINA LAKE
- NAVAIRWARCENWPNDIV POINT MUGU
- NAVAL RESEARCH LABORATORY
- NAVAL RESEARCH LABORATORY CONUS
- NAVAL SURFACE WARFARE CENTER
- NAVAL SURFACE WARFARE CENTER CMD
- NAVAL UNDERSEA WARFARE CENTER
- NAVAL UNDERSEA WARFARE CTR DET KEYPOR
- NAVSESS
- NAVSRFWARCEN DET
- NAVSURFWARCEN EODTECHDIV
- NAVSURFWARCENDIV
- NAVSURFWARCENDLD
- NAVUNSEAWARCENDIV NEWPORT RI
- NAWCTSD
- NSW CARD DIV D
- S FL TEST FACILI
- SPAWARSYSCEN SAN DIEGO
- SPAWARSYSCEN-CHAS

The technical workforce as defined to be any employee at these sites classified within any of the following General Schedule (GS) Occupational Groups as defined by the Office of Personnel Management (OPM):

- GS-100 Social Science, Psychology and Welfare
- GS-400 Biological Science
- GS-800 Engineering and Architecture
- GS-1300 Physical Sciences
- GS-1500 Mathematics and Statistics

The data set was assembled by DACM on 1 June 2009 and includes records on 21391 employees. The record for each employee included gender, age, occupational series, hiring date, salary and site. Other information was included (e.g. pay plan), but not used.

## A.2 Bureau of Labor Statistics Data

Data on the national workforce was acquired from the Bureau of Labor Statistics (BLS) and include the following summaries on the US labor force that may be downloaded from the BLS public website<sup>7</sup> or provided upon request<sup>8</sup>:

- “*Employment status of civilian noninstitutional population by age, sex, and race*” (not seasonally adjusted) for June 2009 – For 5- and ten-year age groups, lists the total number, percentage of the population and percentage of the labor force employed. “Civilian noninstitutional” refers persons 16 years of age and older residing in the 50 States and the District of Columbia who are not inmates and who are not on active duty in the armed forces. This “BLS National Total Workforce Data” was used for Figure 1.
- “*National employment and wage data from the Occupational Employment Statistics survey by occupation, May 2008*” – For each occupation, lists number employed and wage rates. It is referred to here as “BLS National Wage Data.”
- “*Employed persons by detailed occupation, sex, and age, Annual Average 2008 (Source: Current Population Survey)*” – For each occupation, lists the total number employed within 10-year age groups. It is referred to here as “BLS National Employment Rate Data.”

The BLS also computes the Consumer Price Index (CPI). The CPI’s rate of change is the better known inflation rate. The CPI historical data used to normalize the defense outlays was drawn from the document “Table Containing History of CPI-U U.S. All Items, Indexes and Annual Percent Changes from 1913 to Present” that is based on prices of goods and services provided to urban consumers.

## A.3 Office of Management and Budget

Historical data on defense outlays were obtained from the Office of Management and Budget (OMB) document “Outlays by Superfunction and Function: 1940–2009” that was released in August 2009.

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<sup>7</sup> <http://www.bls.gov/>

<sup>8</sup> Stephanie White, (202) 691-6398, [white\\_s@bls.gov](mailto:white_s@bls.gov)

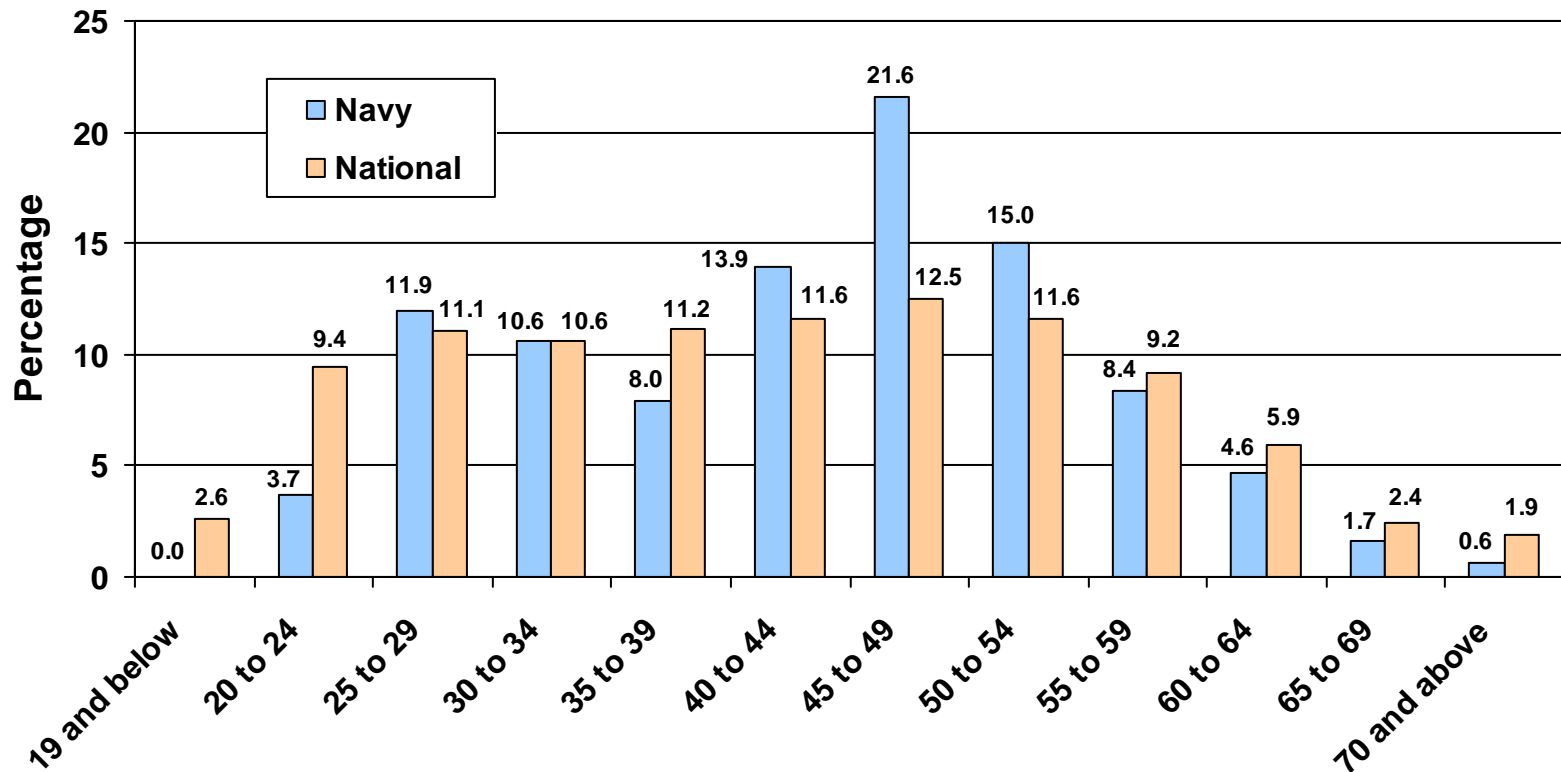
## Appendix B: Comparable Occupational Categories

To make reasonable comparisons between data from the Navy and the Bureau of Labor Statistics (BLS), five academic disciplines were defined and the Federal Civil Service General Schedule (GS) Occupational Series and BLS occupations were assigned to these disciplines as shown in the table below. Each column provides a definition of a technical workforce.

Academic Discipline	Navy Technical Workforce General Schedule Occupational Series		National Technical Workforce	
			BLS National Wage Data	BLS National Employment Rate Data
Life Science (LS)	Ecology	0408	Biochemists and Biophysicists Conservation Scientists Microbiologists	Biological Scientists
	Biological Sciences	0401		
	Microbiology	0403		
	Physiology	0413		
	Toxicology	0415		
Physical Science (PS)	Astronomy & Space Sci.	1330	Astronomers Atmospheric and Space Scientists Chemists Environmental and Health Scientists Geographers Geoscientists Materials scientists Physicists	Astronomers and Physicists Atmospheric and Space Sci. Chemists and Material Scientists Environmental Scientists and Geoscientists Surveyors, Cartographers...
	Cartography	1370		
	Chemistry	1320		
	Gen. Physical Science	1301		
	Geodesy	1372		
	Geology	1350		
	Geophysics	1313		
	Health Physics	1306		
	Metallurgy	1321		
	Meteorology	1340		
	Oceanography	1360		
	Physics	1310		
Engineering (ENG)	Aerospace	0861	Aerospace Biomedical Chemical Civil Computer Hardware Computer Software Applications Computer Systems Software Electrical Electronics Environmental Engineering Managers Engineers, all other Environmental Health and Safety Industrial Marine Eng. and Naval Architects Materials Mechanical Nuclear	Aerospace Biomedical Chemical Civil Computer hardware Electrical and electronics Environmental Industrial Marine Materials Mechanical Nuclear Computer software
	Bio- and Biomedical	0858		
	Ceramic	0892		
	Chemical	0893		
	Civil	0810		
	Computer	0854		
	Electrical	0850		
	Electronics	0855		
	Environmental	0819		
	Fire Protection	0804		
	General	0801		
	Industrial	0896		
	Materials	0806		
	Mechanical	0830		
	Naval Architecture	0871		
	Nuclear	0840		
	Safety	0803		
	Welding	0894		
Mathematics and Information Science (M&IS)	Actuarial Science	1510	Computer and Information Scientists Computer Programmers Computer Support Specialists Computer Systems Analysts Database Administrators Mathematicians Network & Computer Sys. Admin. Network Systems. & Data Communication Analysts Operations Research Analysts Statisticians	Computer Sci. & Sys. Analysts Computer Programmers Computer Support Specialists Database Administrators Network & Computer Sys. Admin. Network Systems & Data Communication Analysts Actuaries Mathematicians Operations Research Analyst Statisticians
	Computer Science	1550		
	Gen. Math & Statistics	1501		
	Mathematics	1520		
	Operations Research	1515		
	Statistics	1530		
Social Science (SS)	Economics	0110	Economists Industrial-Organizational Psychologists	Economists Psychologists
	Psychology	0180		

**Figure 1**

**Age Distribution  
Laboratory/Warfare Center vs National Total Workforce**

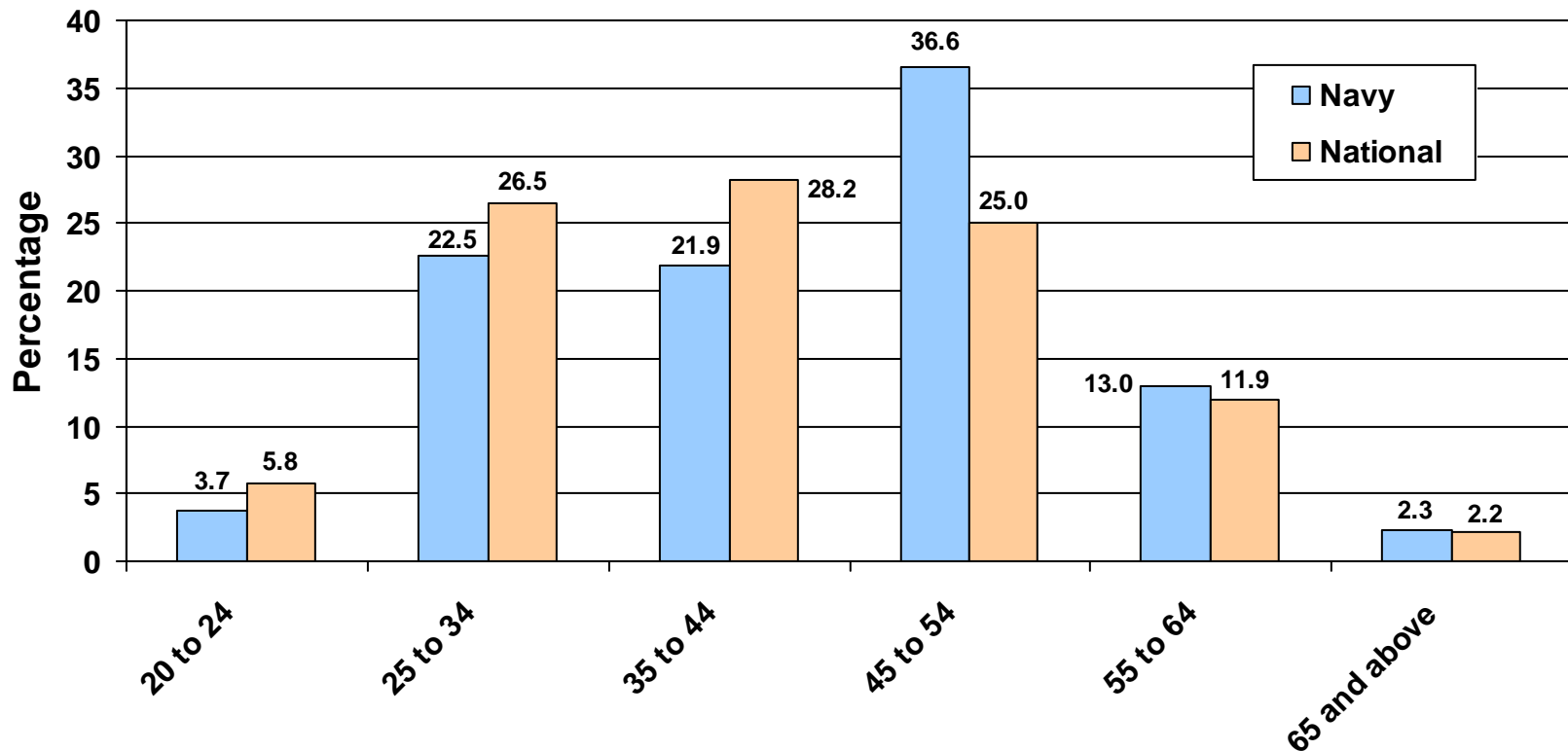


**NOTES:**

- 1) Navy workforce data as of 1 June 2009 provided by the Director, Acquisition Career Management, ASN(RDA)
- 2) National workforce from Bureau of Labor Statistics demographic employment data, June 2009
- 3) Number of Navy employees is 21,311 and includes members of the Senior Executive Service, but not student trainees; number of employees in national workforce data is 138.9 million
- 4) Navy data includes employees of the Naval Research Laboratory and all warfare centers

**Figure 2**

**Age Distribution  
Laboratory/Warfare Center vs National Technical Workforce**

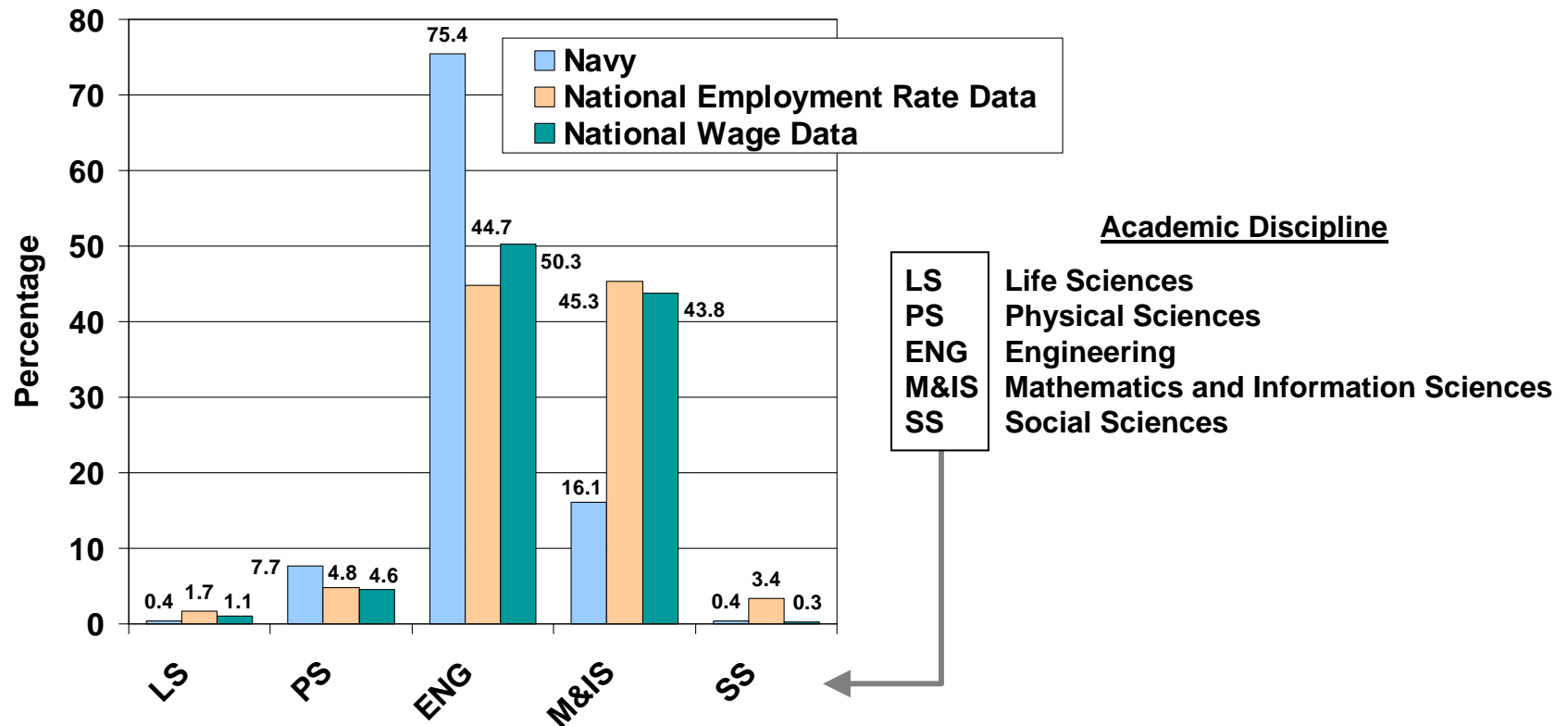


**NOTES:**

- 1) Navy workforce data as of 1 June 2009 provided by the Director, Acquisition Career Management, ASN(RDA)
- 2) National workforce data from Bureau of Labor Statistics 2008 annual average demographic employment data for selected occupational groups comparable to the Navy technical workforce
- 3) Number of Navy employees is 21,311 and includes members of the Senior Executive Service, but not student trainees; number of employees in national workforce data is 5.82 million
- 4) Navy data includes employees of the Naval Research Laboratory and all warfare centers

**Figure 3**

**Distribution by Academic Discipline  
Laboratory/Warfare Center vs National Technical Workforce**

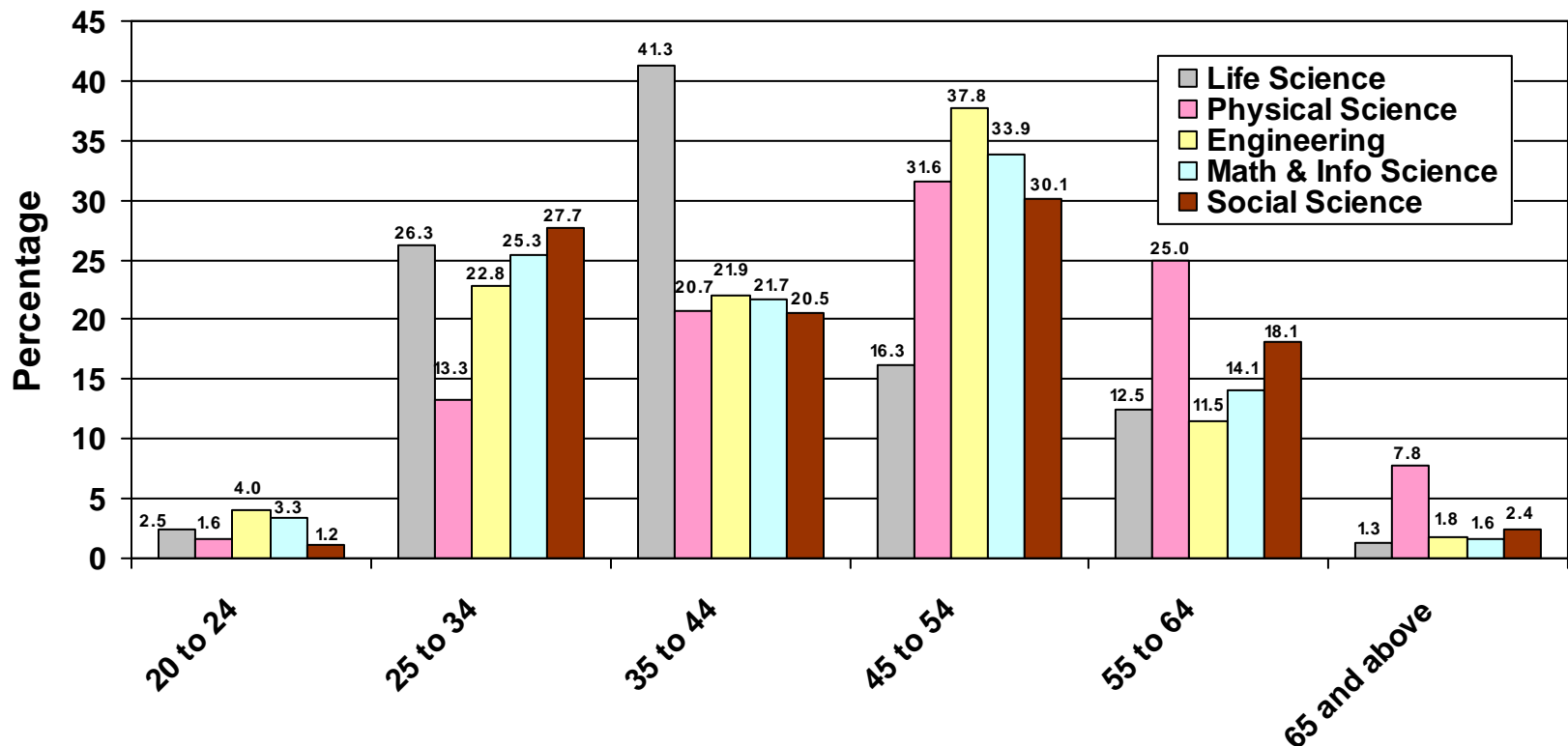


**NOTES:**

- 1) Navy workforce data as of 1 June 2009 provided by the Director, Acquisition Career Management, ASN(RDA)
- 2) National workforce data from Bureau of Labor Statistics occupational wage statistics, May 2008 and 2008 annual average employment rate data
- 3) Number of Navy employees is 21,311; number of employees in national workforce wage data is 5.06 million; number of employees in national workforce demographic data 5.82 million
- 4) Navy data includes members of the Senior Executive Service, but not student trainees
- 5) Navy data includes employees of the Naval Research Laboratory and all warfare centers

**Figure 4**

**Age Distribution by Academic Discipline  
Laboratory/Warfare Center Workforce**

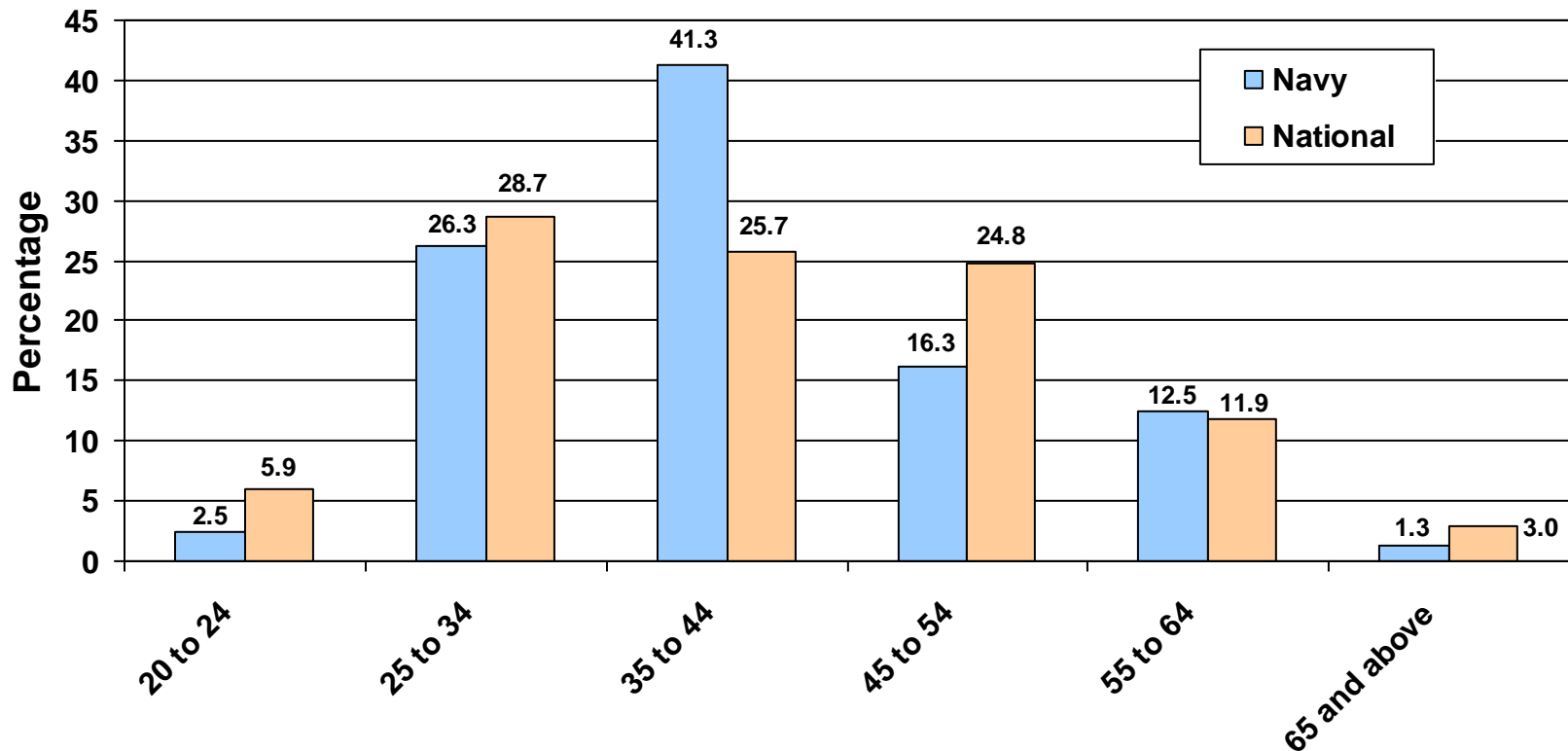


**NOTES:**

- 1) Navy workforce data as of 1 June 2009 provided by the Director, Acquisition Career Management, ASN(RDA)
- 2) Number of Navy employees is 21,311 and includes members of the Senior Executive Service, but not student trainees
- 3) Navy data includes employees of the Naval Research Laboratory and all warfare centers

**Figure 5**

**Age Distribution, Life Science (LS)  
Laboratory/Warfare Center Workforce vs National Technical Workforce**



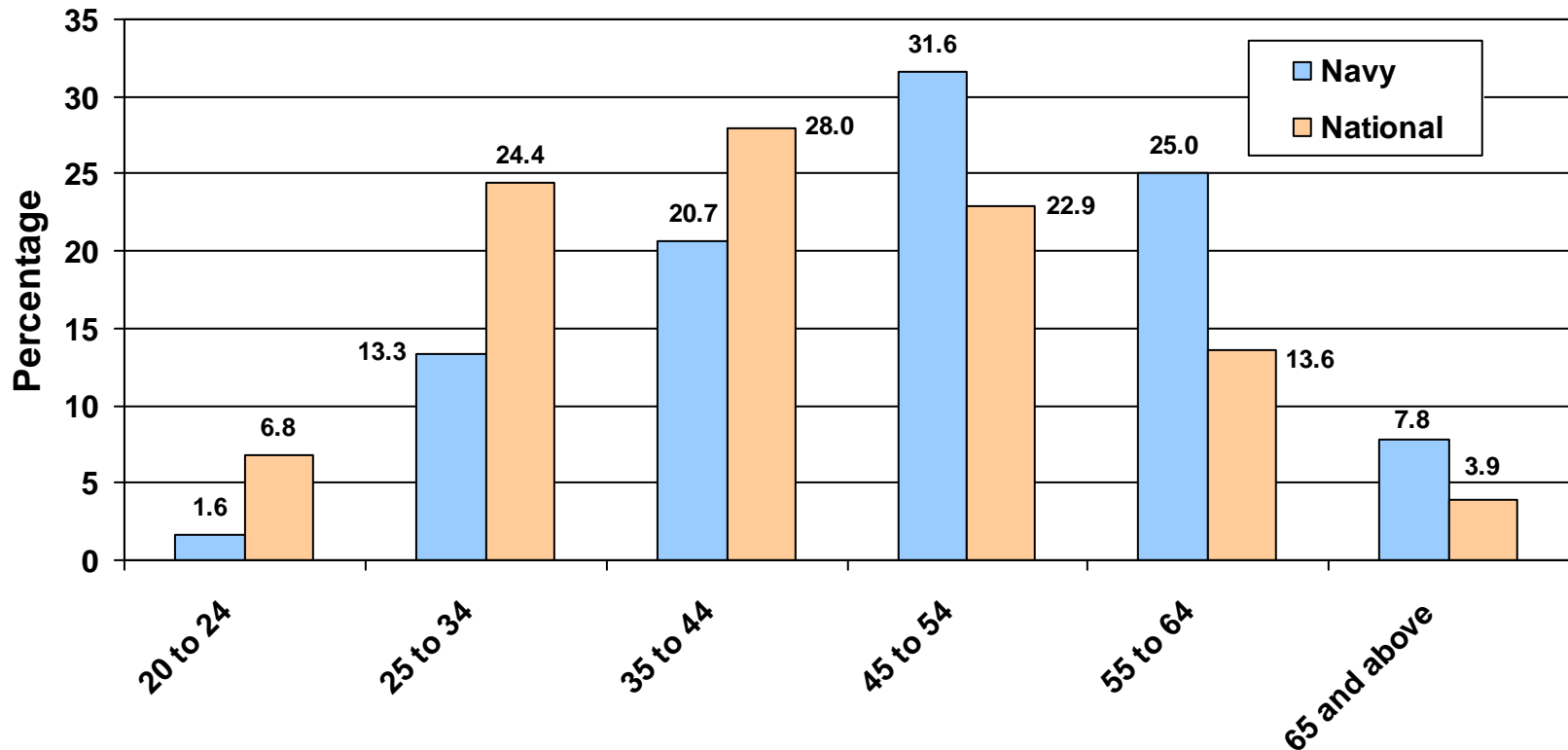
**NOTES:**

- 1) Navy workforce data as of 1 June 2009 provided by the Director, Acquisition Career Management, ASN(RDA)
- 2) Number of Navy employees is 80 and includes members of the Senior Executive Service, but not student trainees; number of employees in national workforce demographic data is 101,000
- 3) National workforce data from Bureau of Labor Statistics 2008 annual average demographic employment data for selected occupational groups comparable to the Navy life science workforce
- 4) Navy data includes employees of the Naval Research Laboratory and all warfare centers



**Figure 6**

**Age Distribution, Physical Science (PS)  
Laboratory/Warfare Center Workforce vs National Technical Workforce**

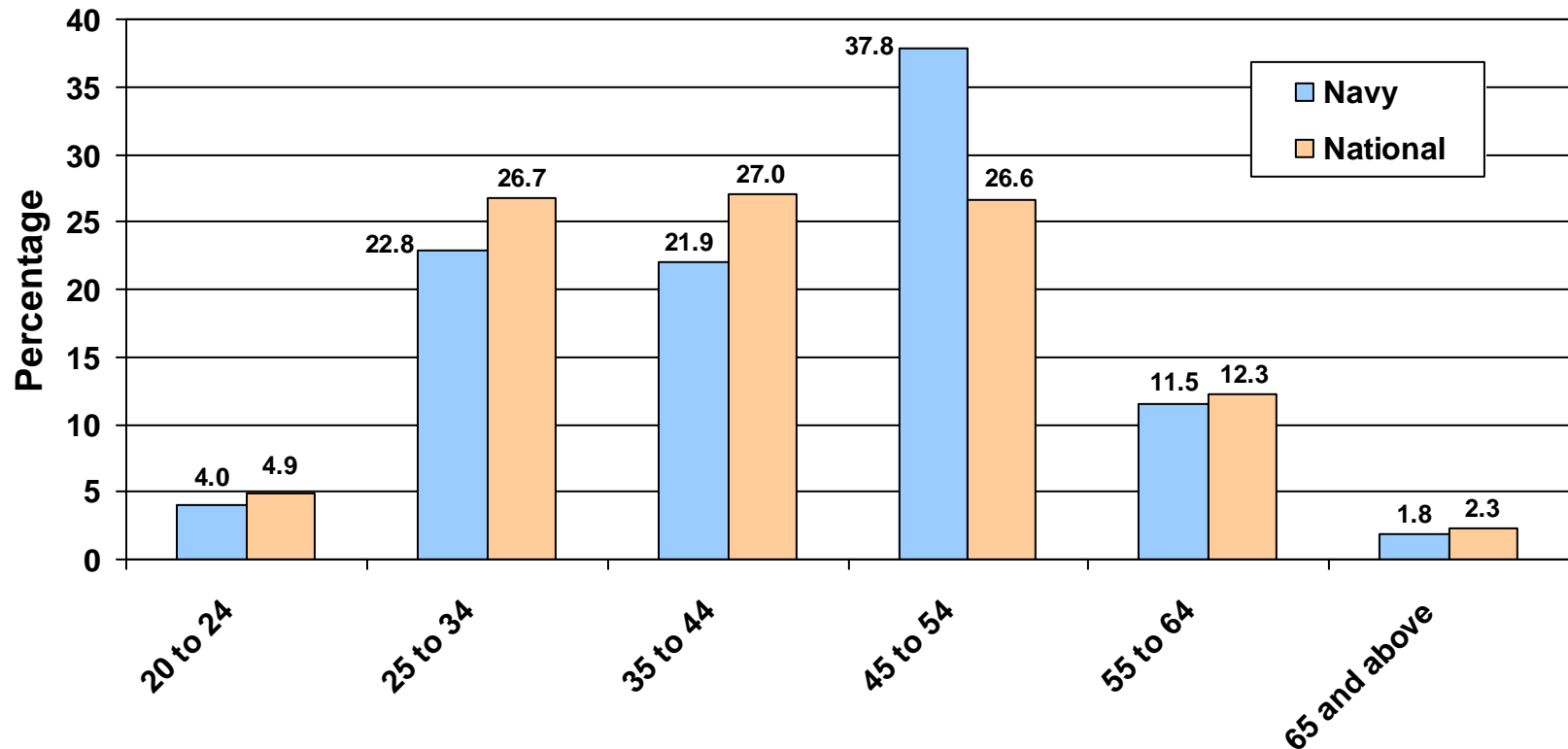


**NOTES:**

- 1) Navy workforce data as of 1 June 2009 provided by the Director, Acquisition Career Management, ASN(RDA)
- 2) Number of Navy employees is 1,648 and includes members of the Senior Executive Service, but not student trainees; number of employees in national workforce demographic data is 279,000
- 3) National workforce data from Bureau of Labor Statistics 2008 annual average demographic employment data for selected occupational groups comparable to the Navy physical science workforce
- 4) Navy data includes employees of the Naval Research Laboratory and all warfare centers

**Figure 7**

**Age Distribution, Engineering (ENG)  
Laboratory/Warfare Center Workforce vs National Technical Workforce**

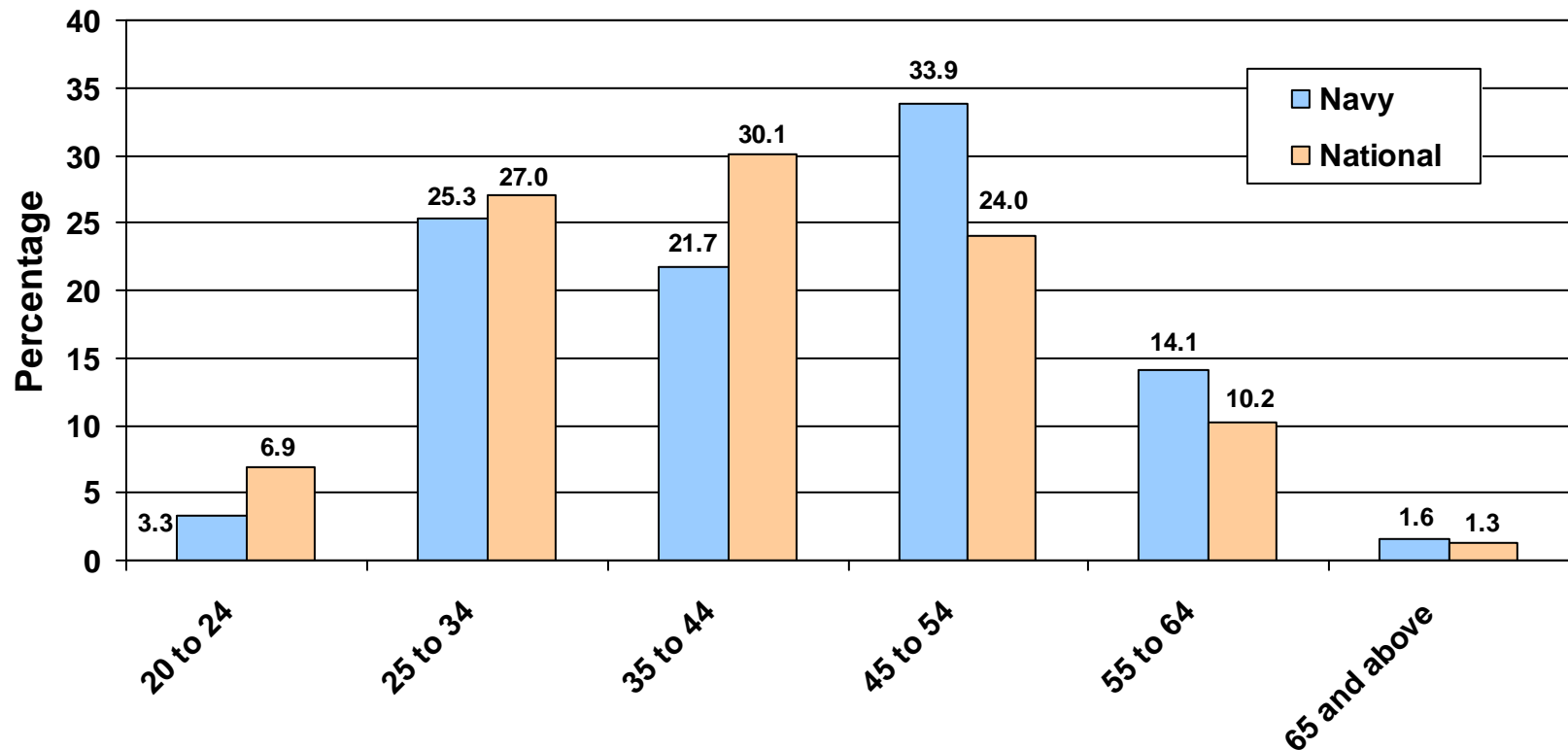


**NOTES:**

- 1) Navy workforce data as of 1 June 2009 provided by the Director, Acquisition Career Management, ASN(RDA)
- 2) Number of Navy employees is 16,069 and includes members of the Senior Executive Service, but not student trainees; number of employees in national workforce demographic data is 2.60 million
- 3) National workforce data from Bureau of Labor Statistics 2008 annual average demographic employment data for selected occupational groups comparable to the Navy engineering workforce
- 4) Navy data includes employees of the Naval Research Laboratory and all warfare centers

**Figure 8**

**Age Distribution, Mathematicians and Information Science (M&IS)  
Laboratory/Warfare Center Workforce vs National Technical Workforce**

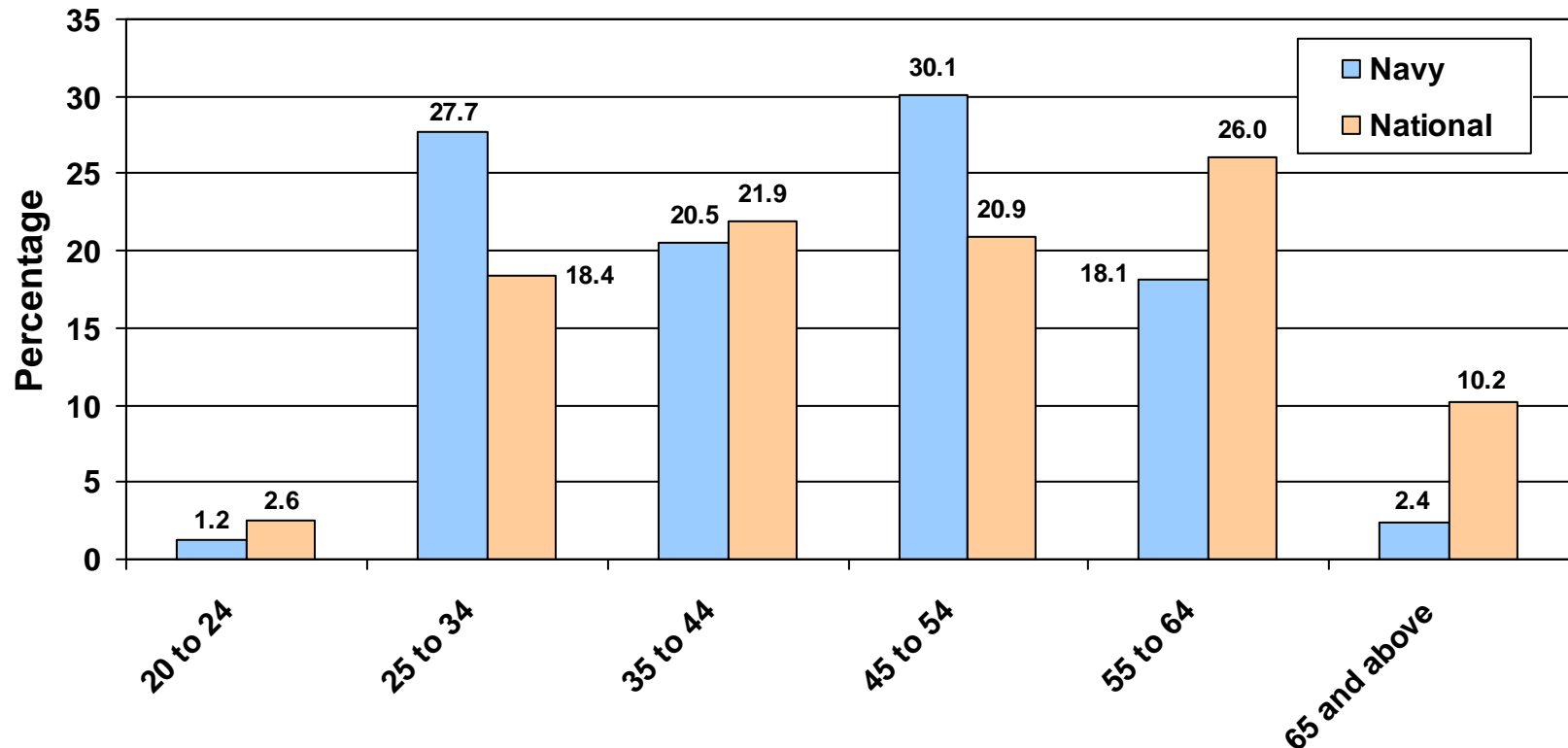


**NOTES:**

- 1) Navy workforce data as of 1 June 2009 provided by the Director, Acquisition Career Management, ASN(RDA)
- 2) Number of Navy employees is 3,441 and includes members of the Senior Executive Service, but not student trainees; number of employees in national workforce demographic data is 2.64 million
- 3) National workforce data from Bureau of Labor Statistics 2008 annual average demographic employment data for selected occupational groups comparable to the Navy mathematics and information science workforce
- 4) Navy data includes employees of the Naval Research Laboratory and all warfare centers

**Figure 9**

**Age Distribution, Social Science (SS)  
Laboratory/Warfare Center Workforce vs National Technical Workforce**

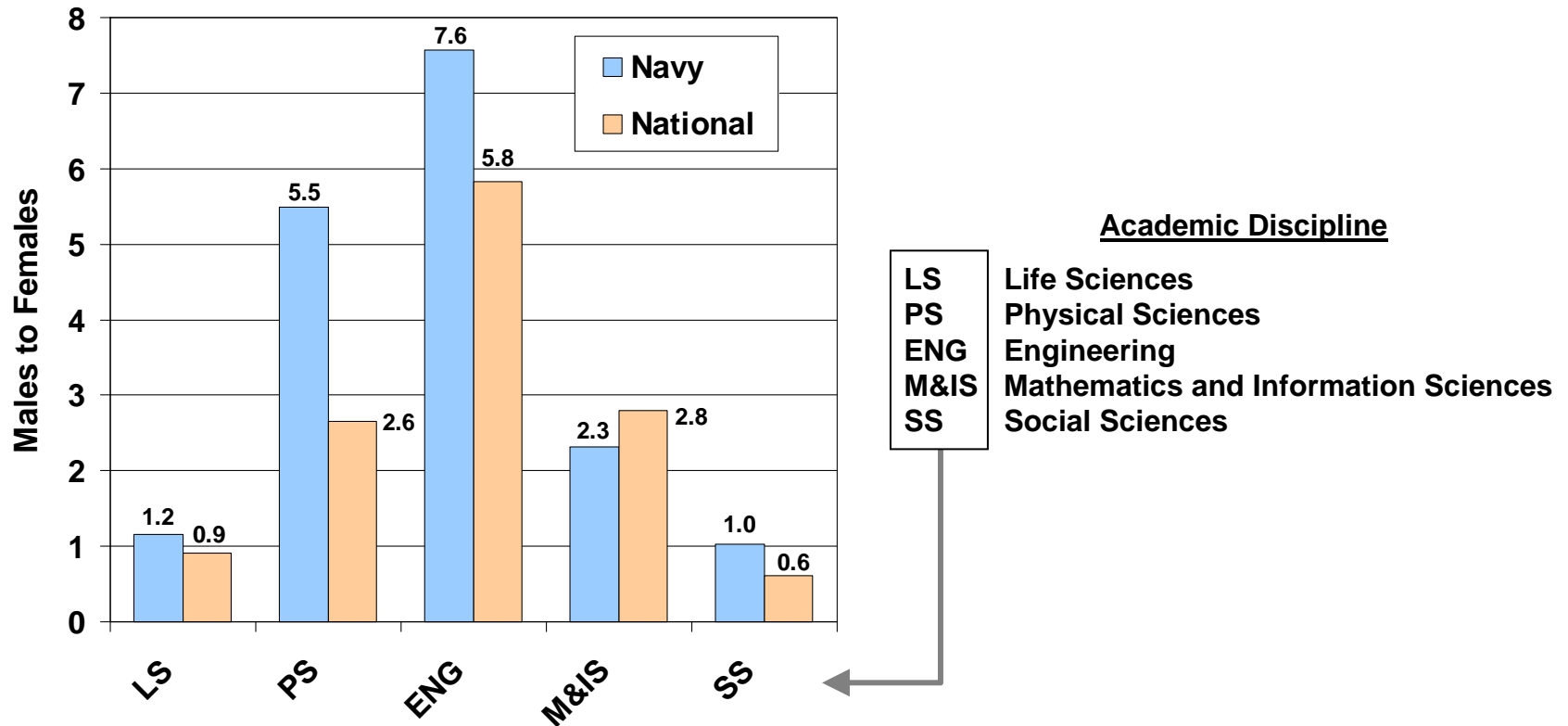


**NOTES:**

- 1) Navy workforce data as of 1 June 2009 provided by the Director, Acquisition Career Management, ASN(RDA)
- 2) Number of Navy employees is 83 and includes members of the Senior Executive Service, but not student trainees; number of employees in national workforce demographic data is 196,000
- 3) National workforce data from Bureau of Labor Statistics 2008 annual average demographic employment data for selected occupational groups comparable to the Navy social science workforce
- 4) Navy data includes employees of the Naval Research Laboratory and all warfare centers

**Figure 10**

**Male-to-Female Ratio by Academic Discipline  
Laboratory/Warfare Center vs National Technical Workforce**

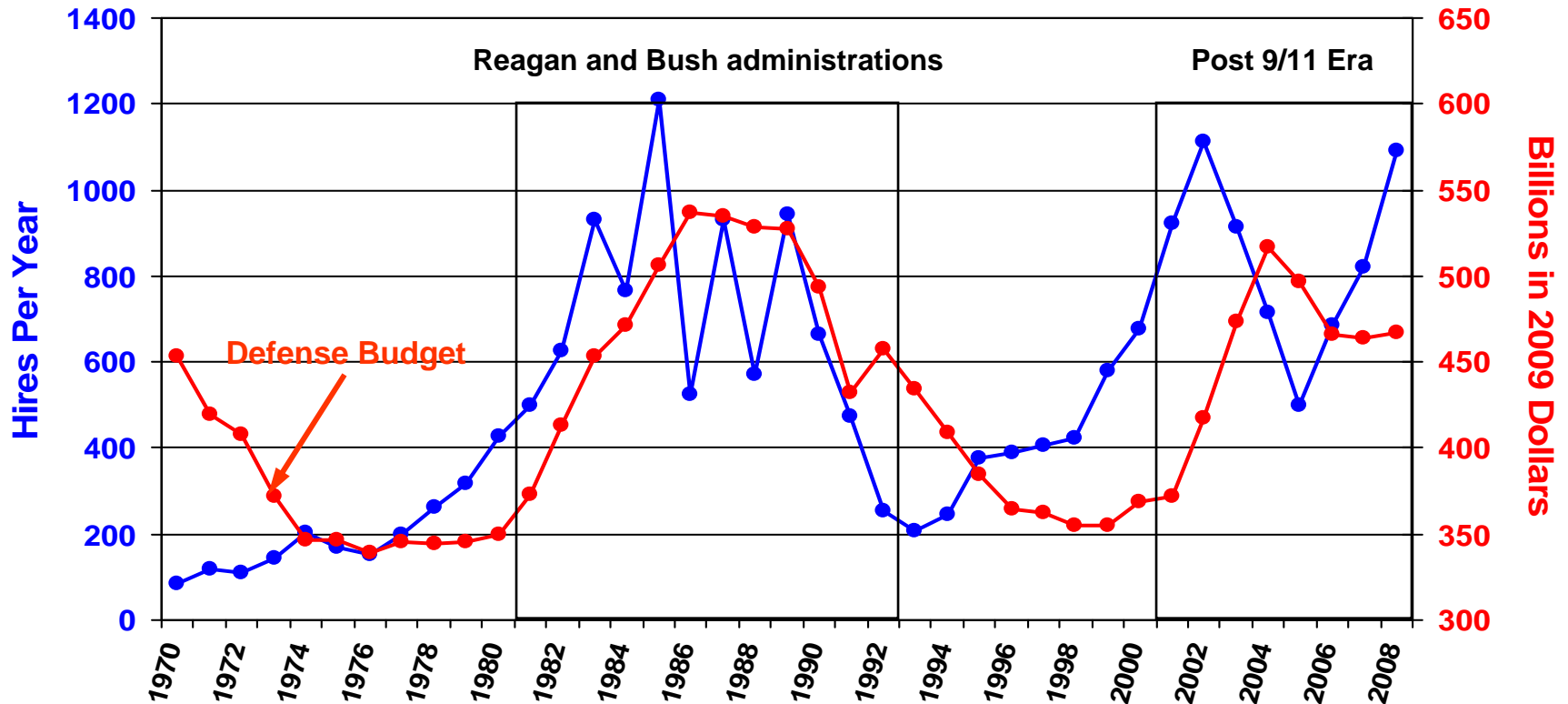


**NOTES:**

- 1) Navy workforce data as of 1 June 2009 provided by the Director, Acquisition Career Management, ASN(RDA)
- 2) National workforce data from Bureau of Labor Statistics 2008 annual average demographic employment data
- 3) Number of Navy employees is 21,311; number of employees in national workforce demographic data 5.82 million
- 4) Navy data includes members of the Senior Executive Service, but not student trainees
- 5) Navy data includes employees of the Naval Research Laboratory and all warfare centers

**Figure 11**

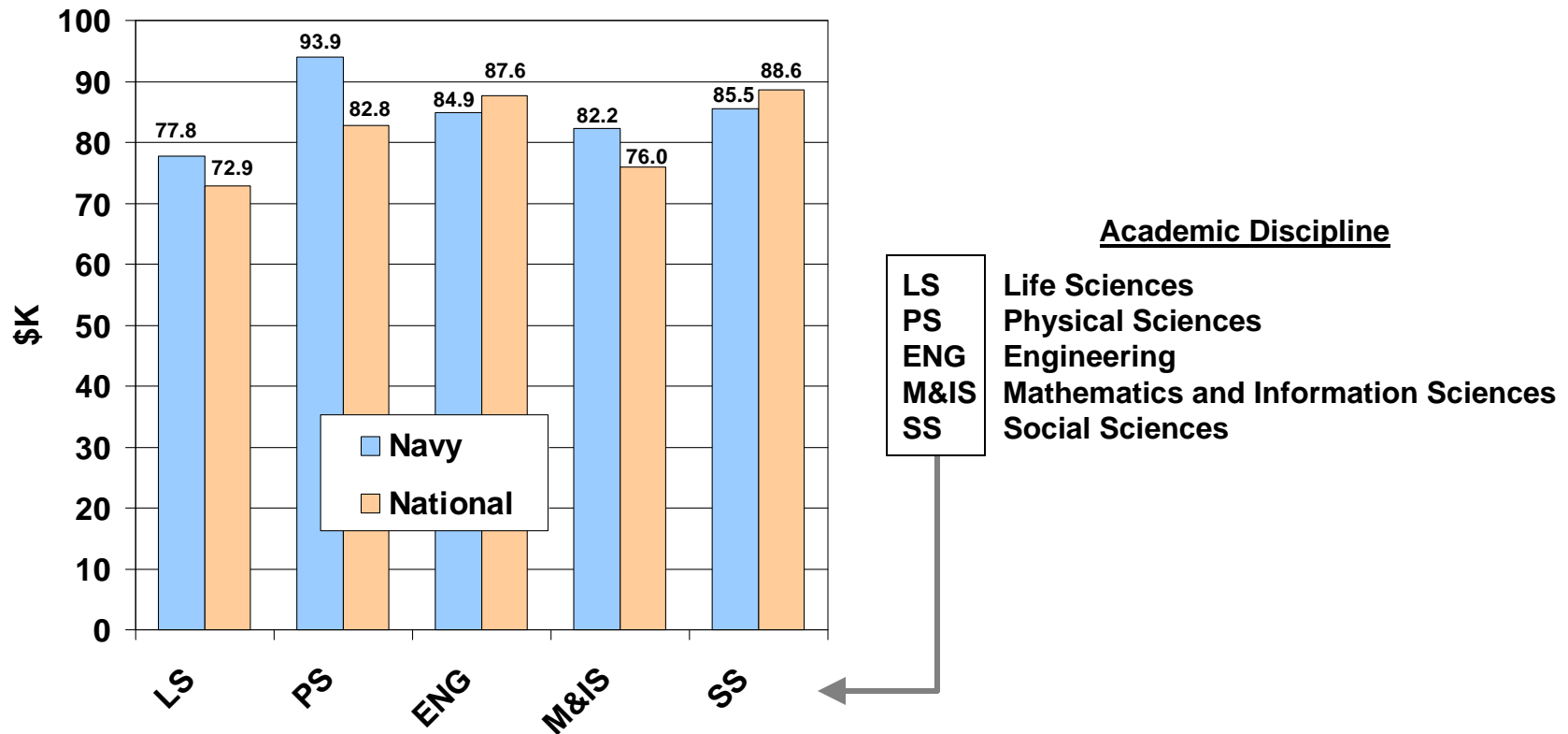
# **Laboratory/Warfare Center Estimated Hiring Rate**



**NOTES:**

- 1) Navy workforce data as of 1 June 2009 provided by the Director, Acquisition Career Management, ASN(RDA)
- 2) Number of Navy employees is 21,311 and includes members of the Senior Executive Service, but not student trainees
- 3) Navy data includes employees of the Naval Research Laboratory and all warfare centers
- 4) Box showing Reagan and Bush administrations include years for which those presidents were in office during an entire federal budget cycle or a significant portion thereof
- 5) Defense budget is from Office of Management and Budget data tables on outlays by government function and adjusted by the Consumer Price Index computed by the Bureau of Labor Statistics. Does not include special appropriations.

**Figure 12**  
**Salary by Academic Discipline**  
**Laboratory/Warfare Center vs National Technical Workforce**



**NOTES:**

- 1) Navy workforce data as of 1 June 2009 provided by the Director, Acquisition Career Management, ASN(RDA)
- 2) National workforce data from Bureau of Labor Statistics occupational employment statistics, May 2008
- 3) Number of Navy employees is 21,311; number of employees in national workforce wage data is 5.06 million
- 4) Navy data includes members of the Senior Executive Service
- 5) Navy data includes employees of the Naval Research Laboratory and all warfare centers
- 6) Navy data does not include 76 student trainees, as the exact nature of their expertise and duties are not specified

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